WAR SURGERY

OF THE

FACE

A TREATISE ON PLASTIC RESTORATION AFTER FACIAL INJURY

BY

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A B.

TO MY WIFE

Mary Eleanor Roberts

COMPANION AND COUNSELOR

PREFACE

The possibility of correcting a hideous distortion of features or replacing a large section of the human face was realized inadequately until this great European War produced so many mutilations. The public at large and even a considerable number of members of the medical profession were unfamiliar with the advances made in plastic surgery. Military surgeons were soon confronted with problems with which they were unfamiliar; but they quickly used with ever-increasing skill the reparative methods of Tagliacozzi, Szymanowski, Nélaton, Wolfe, Lexer, Morestin, Esser and other workers.

The experiences of surgeons and oral surgeons in army and navy services of the divers nations at war have given rise to a valuable literature of both prosthetic and operative treatment of facial wounds. The author has endeavored to correlate the results of military and civil practice in traumatic surgery of the face, realizing that the fundamental principles of surgical science hold sway in both provinces.

Reparative surgery of the face follows identical methods for reconstruction of wounds received in warfare and those caused by industrial accident. The author hopes that this book may be useful in both fields. Such value as it may have is largely due to the continued interest in its production shown by Col. V. P. Blair and Major R. H. Ivy, of the Medical Corps of the United States Army. The volume is really the outcome of an after-dinner chat in Washington, when its preparation was suggested by one of these able oral surgeons.

Thanks are due also to Dr. William L. Schreiber and Dr. W. H. L. Hale for loyal services as operative associates and for suggestions while the book was going through the press.

JOHN B. ROBERTS.

PHILADELPHIA, January 15, 1919.

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I. SURGICAL ANATOMY OF THE FACE

CHAPTER I.

THE SUPERFICIAL OR CLINICAL ANATOMY OF THE FACE.

In the present study, the face includes more than that which is called the face in a strict anatomical sense. The frontal and temporal regions of the cranium must be included. Congenital and traumatic deformities occur in the ears and the forehead as well as in that portion of the head usually called the face in anatomical treatises. The bones and soft tissues of the region, the surgery of which is to be discussed, need not be minutely described; but a general view will be valuable. Good surgery of any region of the body is impossible without a knowledge of the bony landmarks and the mutual relations of the soft parts. The blood supply and the location of the important nerve trunks and ducts are topics of special interest.

If the face is looked at from in front, it is bounded laterally above by the bulge of the parietal bones, behind the coronal suture, and by the anterior part of the squamous portion of the temporal bones. The narrowest part of the forehead lies between the temporal crests or ridges, about half an inch above the external angular process. This is situated at the upper and outer part of the orbit. The lower part of the face, the shape of which is determined by the form of the mandible, or lower jaw, is bounded below by the upper portion of the throat and neck. This region also is of importance in the plastic surgery of the face, because the soft tissues of the throat and neck are often used in reconstructive operations about the mouth.

In this hasty survey it will perhaps be sufficient to call attention to only a few of the most prominent anatomical features of the bony skeleton. Across the frontal bone and below the frontal eminences will be observed two transverse furrows, which are just above the superciliary ridges. Below these ridges are situated the supraorbital arches which form the upper margin of the eye sockets. They show at about one-half inch

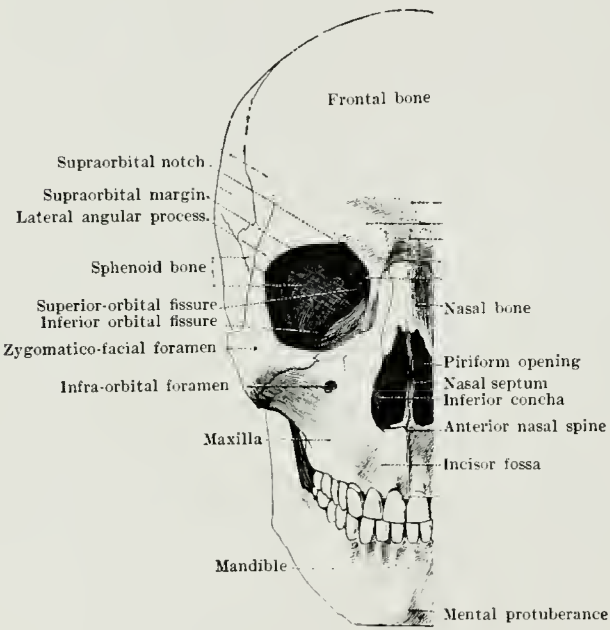


Fig. 1.— Anterior view of cranium and face. (*From Dixon.*)

from their inner end the supraorbital notches, or foramina, through which pass the supraorbital nerve and vessels. The situation of this notch and the artery coming through it have an important bearing upon the position of the pedicle of the flap in frontal rhinoplasty. A well-known landmark is the glabella, the smooth surface in the middle line just above the depression made by the junction of the frontal bone and the nasal bones. The midpoint of the suture between the frontal bone and the nasal bones is called the nasion.

Very conspicuous are the two eye-sockets which, somewhat quadrilateral in shape, have rounded margins of very compact bone. These margins are formed by the frontal, malar, and superior maxillary bones. The situation of the lachrymal gland underneath the upper and outer angle of the orbital margin should be recollected; and the groove for the lachrymal sac at the inner and lower angle must not be forgotten by the operating surgeon. The infraorbital foramen, through which pass the

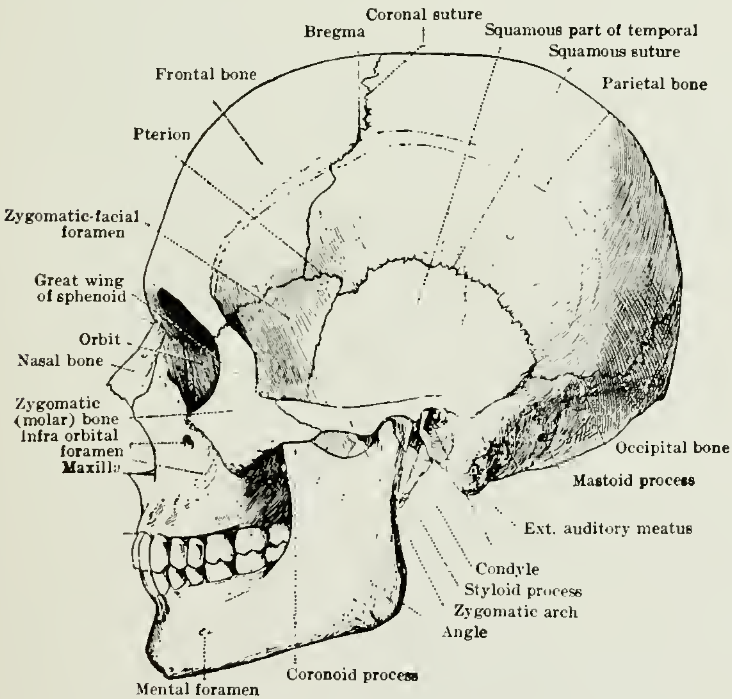


Fig. 2 — Lateral surface of cranium and face. (*From Dixon.*)

infraorbital nerve and vessels, lies about a quarter of an inch below the lower orbital margin, and almost vertically above the second bicuspid tooth. Occasionally there are two openings here; probably because the vessels and nerve do not always come through the same foramen.

The pyriform aperture of the nasal chambers, below and between the orbits, is in shape like an inverted ace of hearts. Its

long axis is vertical and its margins, formed by the two nasal and two superior maxillary bones, has a rather sharp and easily broken edge. The prominent nasal spine below for the attachment of the columella is of some surgical importance. In the skeleton there is seen within the nasal aperture the anterior edge of the osseous nasal septum. It is made up of the vomer below and the nasal, or vertical, lamella of the ethmoid bone above. The nasal aperture is much contracted by the nasal cartilages, which form the basis of the projecting portion of the nose. A clear understanding of the cartilaginous attachments and of the influence of the bony and cartilaginous septum of the nose upon its shape are essential to successful plastic work upon this organ. Many very unsightly deformities of the face are due to inefficient treatment of nasal fractures. The anterior portion of the inferior turbinal bone is seen by looking into the anterior nostrils.

The malar bone, or zygomatic, makes the prominence of the cheek, is attached to the zygoma of the temporal bone, and has a great deal to do with the shape of the face, as the configuration of the cheek depends upon it. In its normal configuration it varies much in different races. This can be easily appreciated by comparing the face of the North American Indian with that of an individual of the yellow or the white race.

The manner in which the malar bone assists in making the arch spanning the temporal fossa is the cause of the unseemly deformity which arises when blows in this region crush in the arch. Elevation of the broken bone is an exceedingly simple operation, and yet is not always performed after the receipt of such injuries. The crushing of the anterior wall of the hollow upper jaw creates another deformity of a similar kind, which is sometimes allowed to cause permanent disfigurement by being unscientifically treated.

The upper jaw is a bone of major importance in the construction of the face, for it takes part in forming the walls of the orbit, the nose and the mouth. Its alveolar arch must correspond with the same portion of the lower jaw in such a way that the upper teeth may lie in front of the lower teeth when the mouth is closed. Mal-occlusion of the upper and lower teeth may be due to abnormality in irruption of the teeth or to imperfect or asymmetrical development of the jaw or the mandible. The incisive

portions of the two upper jaw bones are developed by special centers of ossification. They therefore have much to do with the deformities of the lower portion of the face and mouth. Harelip and cleft palate are the most conspicuous and commonly recognized congenital deformities due to improper development of this portion of the facial skeleton. In some cases of double harelip there exists a projecting prominence of bone, because the premaxillary elements of the incisive region fail to unite with the rest of the upper jaw.

A most conspicuous deformity is that in which the lower jaw with its teeth project in front of the upper jaw. This deformity is said to be due at times to a precocious ossification of the sutures between the body of the upper jaw and the incisive or intermaxillary portions. As a result, the upper jaw and the teeth belonging to it do not develop in a forward direction as

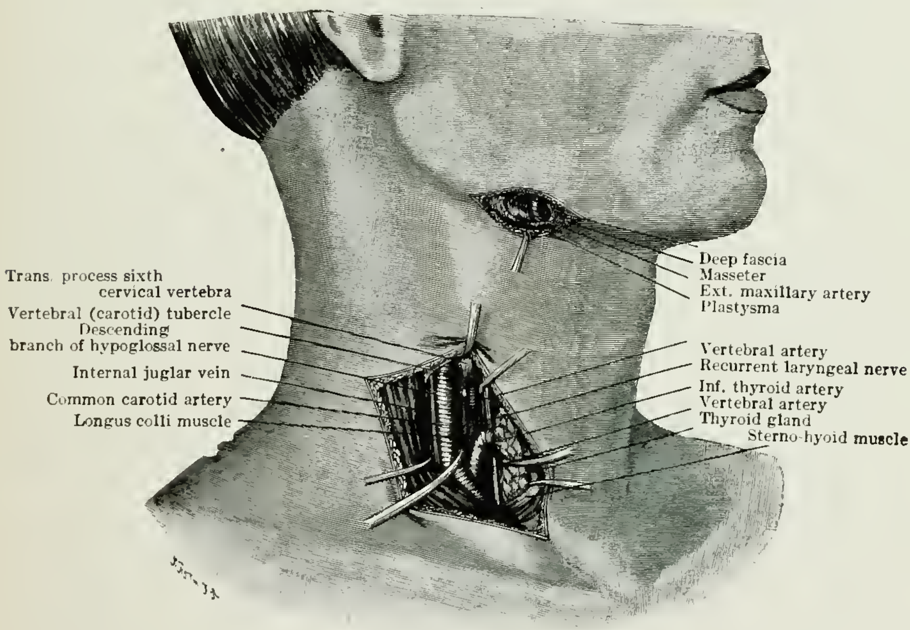


FIG. 3.—Exposure for ligation of the external maxillary (facial) artery where it crosses the lower border of the mandible; ligation of the inferior thyroid artery; and ligation of the common carotid low in the neck.
(*From Kocher.*)

much as they ought, and the lower jaw consequently gains an undue prominence. It thus alters the shape of the lower segment of the face. The proper understanding of the cause of the deformity will prevent many children from becoming conspicuously uncomely. Mechanical appliances may be used by the dental surgeon to prevent the impending ugly alteration in the relation of the two jaws. Habitual mouth breathing in childhood may lead to imperfect development of the nasal accessory air sinuses and consequent modification of the facial contour. Obstruction of the nasal and nasopharyngeal chambers from fracture, enlarged adenoid structures or tumor should therefore receive wise surgical treatment in the young.

The mandible, or lower jaw, gives form to the lower part of the face and to a certain extent the cheeks. It is one of the most important of the bony elements of the face and has an exceedingly great, direct and indirect, influence upon the appearance of the individual.

The chin or mental process is often marked by a median notch, on each side of which is a blunt swelling or tubercle. From this ascends an oblique line to meet its fellow of the other side below the sockets of the incisor teeth. An external oblique line runs backward from the mental tubercle to the level of the last molar tooth. Above this line and below the second pre-molar, or biscuspid, tooth is the mental foramen through which passes the mental nerve and vessels. It is said that the lower jaw has a special tendency to become necrotic, because its arterial supply depends upon the integrity of the two mental arteries. The other bones of the face are particularly well supplied with blood because of the large number of vessels running into them. The groove for the facial artery, found at the lower edge of the mandible in front of the attachment of the massenter muscle, is a landmark of importance. Temporary pressure may be made upon the artery at this point to lessen the bleeding in operations upon the face.

The angle between the body of the lower jaw and its ascending ramus varies greatly in different individuals and at different ages. It is very obtuse in infants and much nearer the right angle in adult males. The angle is more obtuse in women than in men. In the adult male it is about 122°. Changes in the

angle of the jaw and the prominence of the chin, produced by the loss of the teeth and the absorption of the alveolus in old age, give the characteristic appearance to the senile face. This may be prevented by the early adoption of artificial dentures.

Medical men as a rule pay too little attention to the influence of a proper development of the teeth upon the shape of the mouth, chin and the lower face. While the facial angle, studied by Camper and others, has been a subject of interest to physicians as well as to artists, the influence of the teeth and jaws upon personal comeliness has been almost entirely overlooked in medical practice.

Anchylosis of the temporo-maxillary joint, preventing movement of the lower jaw, will, if occurring in childhood, lead to atrophy or want of proper development of the bone. As a result the patient grows up with an immature chin which causes very conspicuous disfigurement. Burns of the lower part of the face and of the neck will prevent proper mobility of the mandible and lead in growing children to a lengthening and bending downward of the front of the lower jaw bone. Persistent thumbsucking in young children, after the second dentition, causes deviation of the teeth, particularly of the upper jaw, and therefore an abnormal relation of the upper and lower jaw bones.

A lateral view of the region under consideration shows, in the upper portion, the anterior part of the curved temporal ridge, or crest, where it runs into the external angular process of the frontal bone. This bony prominence extends downward to join the corresponding process of the malar, or zygomatic, bone which bounds the temporal fossa in front. At right angles to the base of this anterior wall of the temporal fossa and extending backward is the zygomatic arch, made by contiguous processes of the malar and temporal bones.

In front and above the temporal crest are seen the bulging frontal prominences which constitute the forehead. These frontal eminences are better marked in young persons and in women than in adult males. Beneath the frontal prominences is seen the shallow transverse furrow of the forehead. Beneath this are the superciliary ridges, forming the lower limit of the forehead, and the supraorbital arches which constitute the upper limits of the eye sockets. The superciliary ridges are directed

obliquely upward and outward and are better marked in the adult, because the frontal sinuses, or air cavities, beneath them develop with the increasing age of the child. It is this increased prominence of the superciliary ridges, due to the frontal sinuses within, that makes the frontal eminences relatively smaller in the adult male than in women and children. The frontal sinus begins to develop at about seven years of age.

Fig. 4.—Roentgenogram of left frontal sinus. (*From Beesly and Johnston.*)

The point where the temporal crest crosses the coronal suture is called the stephanion. The temporal fossa in which lies the temporal muscle, covered by the temporal fascia, is in many faces indicated by a marked depression. This is particularly the case in persons who are lean. The emaciation of illness is often the cause of great change in the face because of the absorption of fat in this fossa. A full appreciation of the construction of the

zygomatic arch is necessary for the proper treatment of deformities in the temporal region. When the bones are covered by the temporal muscle and other soft tissues, the importance of maintaining a proper relation of the bony framework may be overlooked. Fractures here cause great deformity, which is easily overcome by elevating the broken bone so as to reconstruct the normal curve of the arch.

A study of the lower portion of the side of the face makes it at once evident that the lower jaw is the essential bony element. Upon the proper development of the teeth depends the shape of

Fig. 5.—Roentgenogram of skull, showing relation of facial bones to cranial cavity, the situation of the air sinuses of the face and hypophyseal fossa for the pituitary body. (*From Beesly and Johnston.*)

the lower jaw and therefore the configuration of the lower part of the face. This question has been discussed in the remarks made in regard to the appearance of the face from in front. The shape of the angle of the jaw and the manner in which the cheek is formed by the malar bone and ascending ramus of the jaw are apparent when the face is examined on its lateral aspect. The

deviations in the prominence of the nasal bones and the attached soft parts in front are usually observed much better when the face is studied from the side than from in front. The fonimeter of Camper has been employed to measure the facial angle which varies greatly in the different races of man and in different types of the same race.

There are certain of the soft tissues of the face which deserve special attention by the surgeon operating in this region. The foramina for the exit of the terminal branches of the three divisions of the fifth, or trifacial, nerve have passing through them the corresponding arteries and veins. The situation of these vessels is important, because flaps should be cut so as to maintain when possible the integrity of these nerves and vessels. Injury of these nerves usually is not of grave importance because the lesion produces merely a paralysis of sensation, which may be only temporary. Division of the artery may in some cases lead to sloughing of an important part of the flap. This is not of very common occurrence, because of the rich anastomosis of vessels in the facial tissues.

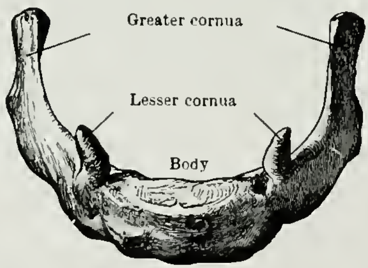


FIG. 6.— Hyoid or lingual bone. (*From Cunningham.*)

The supraorbital foramen is situated at about the juncture of the inner third with the middle third of the supraorbital arch. A line drawn from this point downward and slightly outward, so as to cross the space between the two premolar bicuspid teeth in the upper and lower jaws, passes over the infraorbital and the mental foramina.

The seventh, or facial, nerve, which is the motor nerve of the muscles of expression, makes its exit from the stylo-mastoid foramen, passes through the parotid gland, and breaks up into

branches which radiate toward the temple, the eye, the cheek and the lower jaw. Its existence in this region should not be forgotten, because incisions made transverse to its branches are liable to divide it and cause permanent disfiguring paralysis of muscles. The manner in which its branches radiate from behind

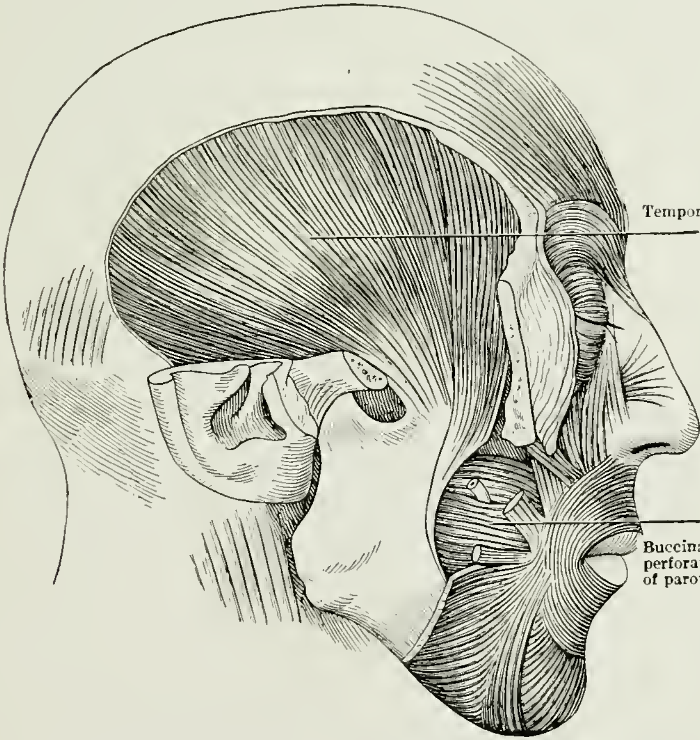


FIG. 7.— Masseter muscle and zygoma removed to show temporal muscles. (*From Cunningham.*)

and beneath the lobe of the ear should be remembered. Immediately behind the posterior margin of the ascending ramus of the lower jaw is the external carotid artery, a structure to be carefully avoided when operating between the ear and jaw.

The temporal artery, which is one of the terminal branches of the external carotid, extends upward between the root of the zygoma and the ear and then divides in the temporal region into

an anterior and a posterior branch. These branches are easily seen under the skin of the forehead. The intermaxillary artery is the other terminal of the external carotid artery and passes deeply inward behind the upper jaw in the fissure between it and the pterygoid process of the sphenoid bone.

The transverse facial artery, arising from the temporal, runs forward upon the cheek from in front of the auditory meatus toward the mouth.

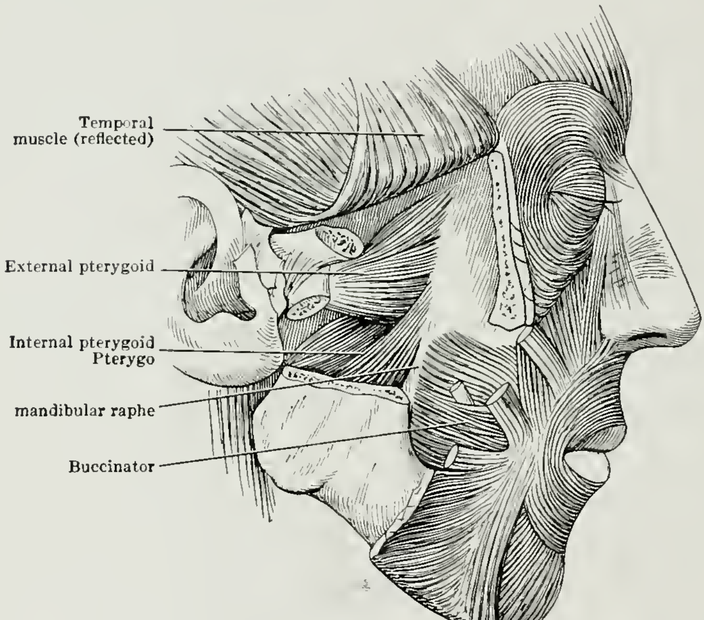


Fig. 8.— Zygomatic arch and part of mandible removed to show deep muscles of mastication. (*From Cunningham.*)

The facial artery, which is a branch of the external carotid in the neck, passes over the lower border of the jaw at the anterior margin of the masseter muscle. It runs obliquely upward to the angle of the mouth, passes along the side of the nose, and terminates at the inner canthus of the eye, where it is called the angular artery. From it arise the coronary arteries which supply the lips and are felt immediately under the mucous membrane. The facial vein does not accompany the tortuous artery, but runs

more directly from the inner angle of the eye to the front of the masseter muscle. The facial artery can be felt and compressed where it crosses the border of the mandible, and also from within the mouth, where it lies under the mucous membrane near the corner of the mouth.

A very important structure which must be avoided in incisions upon the face is the duct of the parotid gland. It is a firm white tube about the size of a goose quill. It runs parallel to and below the zygoma, on a line drawn from the base of the lobe of

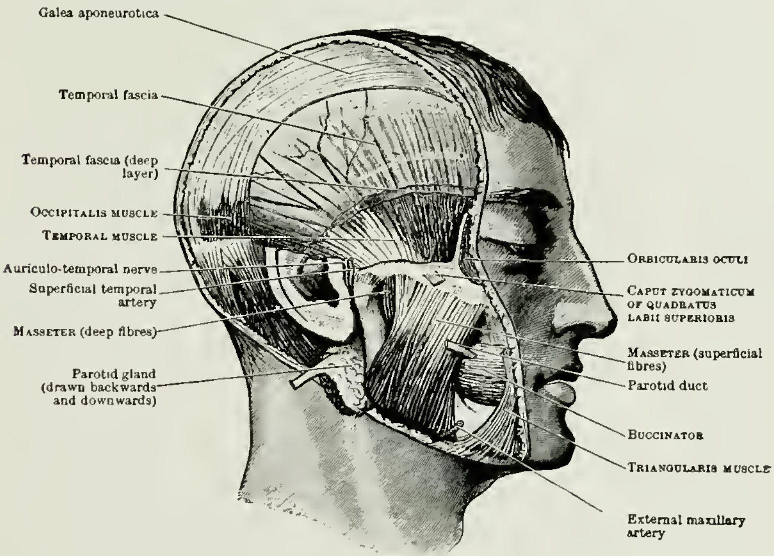


Fig. 9.—Muscular relations of lateral mandibular region.

the ear to a point midway between the ala of the nose and the angle of the mouth. About the middle of this line it dips suddenly inward around the front of the masseter muscle, and penetrates the fat and the buccinator muscle to enter the mouth opposite the second molar tooth of the upper jaw.

The parotid gland, filling the irregular space between the mastoid process and the auricle behind and the ramus of the jaw in front, should be remembered. Incisions into it, however, usually do little harm unless the duct of Stenson, already men-

tioned, or one of its larger branches, is injured. A salivary fistula is then likely to be produced.

The eyebrows and eyelids are important structures because wounds involving them may make conspicuous blemishes, unless carefully repaired by suturing. The size of the palpebral fissure has a great influence in making the eyes look large or small. The eyeballs vary very little in size, but a narrow fissure, as in the Chinese race, makes the eye seem very small.

The lachrymal puncta, which are seen as two little black dots on the edge of each lid near the inner angle of the eye, lie close to the ball so as to catch the tears which wash the surface of the eye. Any eversion of this portion of the eyelid due to cicatricial contraction will cause a continual overflow of tears. The surgeon's incisions must be made so as to avoid the production of this everted condition. Care must also be taken to avoid wounding the lachrymal sac at the inner angle of the eye lying underneath the tendo oculi.

The attachments of the nasal and aural cartilages and their general shape should be familiar to operators. The varieties in shape of the nose and ear are very great and will often require surgical interference for their modification. It is not unusual to find the details in the shape of the auricle different on the two sides. This variation is not very important, because both ears are not apt to be critically observed at the same time.

A study of the soft parts of the lips and the mouth shows that there is great variation here also. The mobility of the lips is extreme, though there is a certain amount of fixedness in the middle line. The orbicular muscle of the mouth forms the bulk of the lips. It may be subjected to many operative procedures without the occurrence of much deformity, provided that the relation between the lips themselves and between them and the other features is maintained. A want of balance due to operation or injury may make a very conspicuous deformity which a restoration of the relative proportions will overcome.

Surgeons and medical men in general have very little conception of the importance of the teeth in the physical conformation of the face and the expression of the individual. Many persons suffer a very great, though unnecessary uncomeliness, because the teeth have been allowed to assume irregular positions. As a

result of this, not only the soft parts of the mouth, but even the bony framework of the lower face is permanently changed. A relative over-development of the upper jaw gives an expression similar to that of an imbecile. On the other hand, an over-development of the lower jaw forward produces the prognathous condition which makes the face assume a canine look. These alterations only are mentioned here, so as to call attention to the necessity of early regulation of dental irregularities, which produce all degrees of change in the physiognomy.

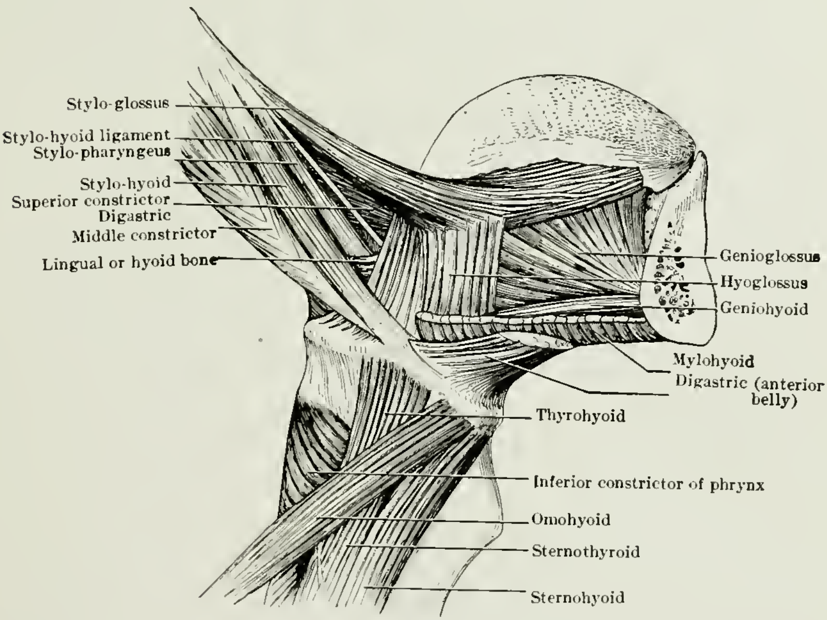


FIG. 10.— Muscles of tongue and hyoid or lingual bone. (*From Cunningham.*)

The face of the infant is small in comparison with the rest of the head; but the development of the accessory sinuses of the nose and of the jaws in the adult alter the relation. The cranium of a baby is five or six times as large as the face. The cranium and face of the adult woman retain to a certain extent an appearance of immaturity and show less marked prominences and ridges than in the man. It is proportionally smaller than the male face and has narrower and less prominent jaws.

The development, as the infant grows, of the superciliary ridges and frontal sinuses in the lower part of the frontal bone makes the frontal eminences less conspicuous; and therefore the forehead assumes a more receding character. The face at birth, in addition to being relatively small, is short in comparison to its breadth, and lacks the prominence of the adult face. The region about the eyes is better developed than the middle and lower portions. The floor of the orbits at their outer sides is situated not much above the bottom of the nasal chambers; the jaws show little alveolar process, because the teeth have not been erupted; the body of the lower jaw is not developed and its rami are very oblique; the chin is small, and the temporal ridge and fossa and the zygomatic arch are inconspicuous.

Bell believed that the fulness, roundness and chubbiness of the infant's face are due to the circumstance that the soft parts are expected to meet the requirements to which they are to be subjected by the increased size of the bony framework of the face in later years. As the child grows, the bones of the face, especially the jaws, increase at a proportionately more rapid rate than those of the cranium; and the face is less round than in the baby. The superciliary ridges, moreover, begin to appear as the frontal sinuses are developed and finally become a prominent characteristic of the face of the adult.

Beneath the skin of the face lie the sheets of muscular tissue, which give expression to the countenance. They have one end attached to the bones of the face, which with the exception of the lower jaw are stationary, and the other end inserted into the under surface of the skin. Contraction of such muscular fibers causes the more movable end and its attached skin to approach the fixed end. This shortening of the fibers rucks the skin up into folds, with intervening wrinkles, which are at right angles to the direction of the muscular pull. In subjects whose skin is thin and flexible the muscular contraction causes many and delicate wrinkles to appear. When the skin is thick and stiff by nature, or as the result of disease, such as myxedema, a slight action of the muscles of expression will produce no visible wrinkling of the surface. The more active muscular contraction required in this case to give evidence of its occurrence will cause

few and thick wrinkles. The delicate shades, variety and beauty of facial expression are absent under such circumstances.

The muscles of expression are difficult of dissection, because they are small, of loose texture, and somewhat pale in color, and from the fact that the removal of the skin dissects away the tissue into which the muscle is inserted.

There are two muscular landmarks on the front of the face — about the eyes and around the mouth. Encircling each orbit is the orbicular muscle of the eyelids. Each of these arises at the inner side from the nasal process of the upper jaw, the tendon of the eyelids, and the frontal bone. It is a sphincter muscle and encircles the orbit, its fibers being inserted on the outer side of the orbit into the external tarsal ligament and the malar bone. The orbicular muscle of the eyelids by its central fibers closes the eyelids. The elliptical fibers running around its outer margin draw the brow down, and the lower eyelid up, thus wrinkling its edges and forcibly closing the eyes. It produces at the outer side of the eye the radiating wrinkles which in old age, when the skin is inelastic and the underlying fat has been absorbed, become very conspicuous and are called "crow's-feet."

A similar orbicular or sphincter muscle, called the orbicular of the mouth, surrounds that opening and constitutes the muscular mass of the lips. It differs from the circular muscle of the eyelids in having its fixed attachments in the middle line above and below, instead of at its outer and inner ends. Its attachment to the upper jaw below the nose and to the lower jaw in the middle line permit the lips to be puckered in whistling. There are two naso-labial muscular slips, which connect the upper lip to the septum of the nose. They have an interval between them which makes the well-known depression in the skin just below the columella. These are accessory fibers of the orbicular muscle. Many of the muscles of expression are inserted into or blend with the fibers of the orbicular of the mouth, and by acting upon it make great changes in the expression of the face.

The so-called occipito-frontal muscle is really two muscles — a posterior attached to one end of the fascia covering the top of the cranium, and an anterior or frontal portion inserted in a similar manner into the front part of that fascia. The frontal portion arises from the nasal bones and the external angular processes

of the frontal bone; it has also an origin from, or attachment to, the fibers of the orbicular of the eyelid and the corrugator of the eyebrow. Its fibers run upward to be inserted into the aponeurosis covering the cranium. The frontal muscle raises the eyebrows and the integument at the root of the nose, bringing at the same time the scalp downward so as to cause transverse wrinkles in the forehead. The typical furrow or line produced by this muscle is concave upward in the middle line and convex upward at its outer extremities.

Sometimes, however, this wrinkle may be a straight line; at other times the central or lateral portion is poorly marked or absent. Occasionally when the central portion is absent, the lateral curves meet or cross each other. This muscle has been called the muscle of attention.

The corrugator supercilli, or wrinkler of the eyebrow, has its orgin at the root of the nose and is inserted into the skin under the eyebrow. It pulls the head of the eyebrow downward and forward, making an angle in the brow near its inner end. It causes a frowning expression, which is also a factor in the expression of pain.

The greater zygomatic muscle arises from the cheek bone and is inserted into the skin and orbicularis oris at the angle of the lips. The lesser zygomatic with a similar origin is seldom present. The elevator of the upper lip arises from the nasal process of the upper jaw and the lower margin of the orbit and is inserted into the upper lip and adjacent portion of the wing of the nose. It is often divided into two parts. The inner is called the elevator of the upper lip and wing of the nose, the outer, the proper elevator of the upper lip. Another small muscle arises from the canine fossa below the eye and is inserted into the lips near the angle of the mouth. It is the elevator of the angle of the mouth.

Arising from the lower jaw not far from the chin are the depressor of the angle of the mouth, the depressor of the lower lip, and the elevator of the lower lip.

The orbicularis oris, when the inner fibers act, draws the lips close against the teeth producing the so-called "biting of the lips," seen in anger or menace. When the outer fibers act, it pouts the lips out as in whistling. When the muscle is relaxed,

the lips turn out in a flaccid condition, giving the face a lack of expression, which is well marked in some types of insanity.

The muscles of the face are in pairs. The frontal and orbicular of the mouth, though each are called by one name, are really composed of two lateral muscles, usually acting as one.

The action of the frontal muscle, as previously stated, is to raise the eyebrows and make transverse wrinkles in the skin of the forehead. It has been alled the muscle of attention. When it acts excessively, it produces the appearance of astonishment.

The two corrugator supercilii muscles pull the eyebrows inward and downward at their nasal ends, making vertical wrinkles between the eyebrows above the root of the nose. This gives an angularity to the inner part of the eyebrow and expresses, by a frowning case of countenance, mental and physical suffering.

The greater zygomatic muscle draws the angle of the mouth upward and outward and gives the expression of laughter or joy, and causes wrinkles under the eyes. The little band of muscle arising from the fascia over the masseter, which is inserted into the corner of the mouth and called the risorius, is not, as its name would indicate, the laughing muscle, but produces a grin or smile. The zygomatic is the true muscle of laughter; and. by pushing up the muscular mass of the cheek, causes the so-called twinkling of the eye which is due to the wrinkles under the eye and not to any change in the eye itself.

A well-marked furrow in the face is the naso-labial line which extends downward and outward from the wing of the nose to a point external to the angle of the mouth. It is seen in all faces, but is more marked in the aged.

The naso-labial line changes its shape with varying emotions. It is an important furrow to the surgeon, since incisions made along its groove show little scar. Incisions across it should be avoided for cosmetic reasons. In laughter the naso-labial line assumes a double curve like the old italic "*S*"; in pain it is straight; in grief, convex outward; in contempt it is drawn in at the lower end and extended around the angle of the mouth.

The elevator of the angle of the mouth assists the zygomatic in indicating joy. The elevator of the upper lip and the elevator of the upper lip and wing of the nose raise the middle portion of the mouth, give the curve of grief to the naso-labial line and pro-

duce an expression of sadness. The corners of the mouth are generally at the same time drawn a little downward by the depressors of the corner of the mouth and the platysma muscles. The elevator of the upper lip and wing of the nose acts upon the nostril to indicate disgust.

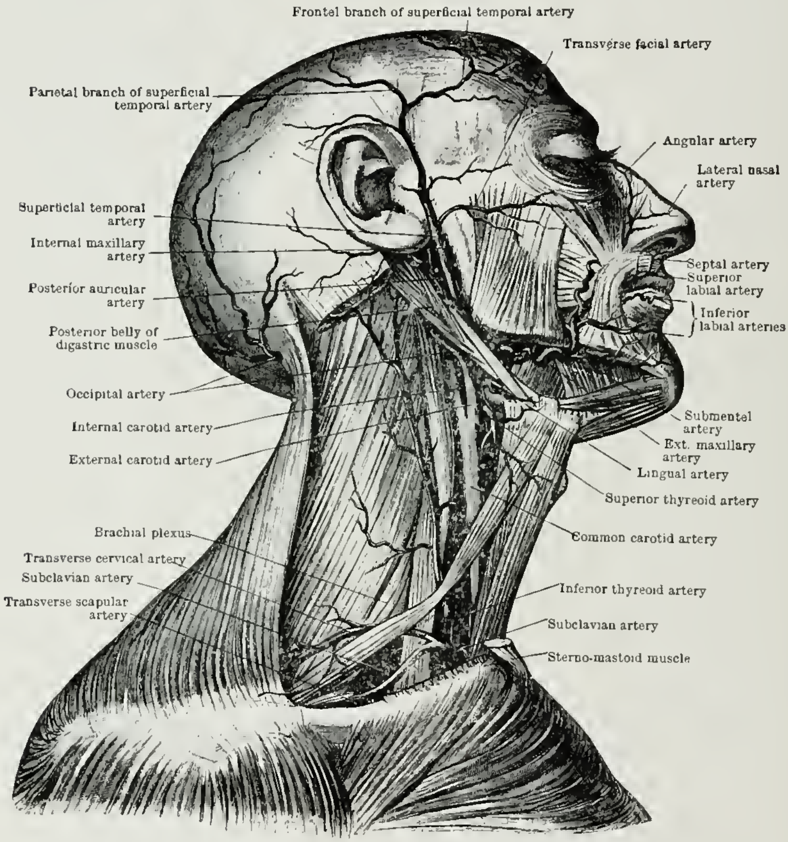


Fig. 11.—Arterial supply of face and neck. (*From Cunningham.*)

The action of the depressor of the lower lip is to thrust the lip a little outward at the same time that it is drawn downward. This gives the expression of scorn. The elevator of the lower lip wrinkles the skin of the chin and at the same time elevates the lip and thrusts it forward. It expresses doubt or disdain. The

tremulous action of this muscle is often noticed in children just before they cry. The corners of the mouth are pulled downward by the depressors of the angle of the mouth and impart the appearance of sadness to the lower portion of the face. They are aided by the elevation of the upper lip which makes the downward movement of the angles of the mouth more conspicuous.

The orbicular muscle of the eyelids consists of two portions, one of which covers the eyelids close to their edges and produces the continuous involuntary winking. The outer portion of the

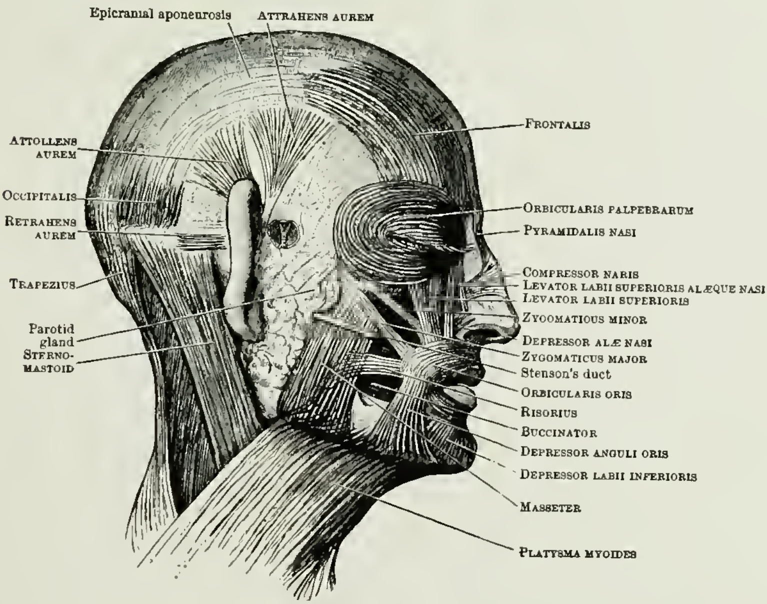


FIG. 12.—Muscles of face and neck. (*From Cunningham.*)

muscle encircles the margin of the orbit. When the whole of the muscle is in action the eyelids are tightly closed. This occurs during coughing, vomiting, or other straining efforts which would tend to force the eyeball forward by the venous congestion in the orbit. The upper portion of this muscle draws the eyebrow downward in opposition to the action of the frontal muscle and thus gives the face an expression of reflection or meditation. A few of the fibers of this muscle which are beneath

the lower eyelid draw that lid downward. This action makes the individual have the appearance of benevolence, frankness or honesty.

The little pyramidal muscle of the nose arising from the nasal bone and running upward draws down the inner end of the eyebrow in the expression of menace. The triangular muscle of the nose running across its bridge wrinkles the skin on the side of the nose in a longitudinal direction. It is said to indicate the emotion of lewdness.

In true emotions the muscles of the various portions of the face act in consonance involuntarily, and produce expressions which seem to us natural. One can, however, by a distinct voluntary effort, bring disassociated muscles into action and thereby produce a grimace.

The surgery of the face must not alter unnecessarily the relations of these muscles of expression. This is particularly important in dealing with the mouth. Many do not appreciate the importance of the lower part of the face in expression. The muscles about the mouth are much more expressive than those about the eyes. This is well known in crude diagrams of the face in which the line of the mouth is the only thing changed. One figure at once suggests mirth, while the other is clearly indicative of grief.

The size and shape of the eyebrows vary very much in different individuals. Occasionally they meet in the middle line above the nose. The chief surgical point in regard to them is that incision made through them should not displace the skin so that the hair will grow unevenly and make conspicuous deformity. Flaps from the head or grafts from the pubes with hairs in them may be transplanted to make eyebrows. Horizontal incisions made along the superciliary ridge among the hairs cause very little displacement, and the scar is hidden by the hair. Oblique or vertical cuts here are likely to leave uncomely distortion of the eyebrow.

When flaps are made from the forehead near the line of the scalp or close to the eyebrows, care should be taken to avoid including any hair-bearing portion of the skin in the flap, unless the hairy portion can be utilized for eyelashes, eyebrows, mustache or beard. When the exigencies of the case require such

flaps to be used, the hair may be destroyed after the flap has taken root in its new position by electro puncture of the hair follicles or by the x-rays. At times incisions may be satisfactorily made across the scalp within the region of hair and the scalp pulled down to give access to the bones of the face. The scar is then covered by the hair. I have satisfactorily used a flap from the hairy scalp for constructing a portion of the cheek in a man. This was unobjectionable because the flap was used to fill an opening in the region of the beard. The hair growing on the flap caused no special disfigurement. The disposition of the tissues, in plastic surgery of the upper lip, must often bear relation to the growth of the mustache.

CHAPTER II.

THE DEEP ANATOMY OF THE FACE.

A detailed study of the anatomical structure of the skeleton and soft parts of the face is useful for a surgeon who essays complicated reparative operations.

THE BONES OF THE FACE.

There is nothing of special importance about the nasal bone, except the crest on its internal surface at the inner edge, and the groove on this same surface for the nasal nerve. The two nasal bones form the bridge of the nose, to which the external cartilaginous nose is attached. Each nasal bone articulates with

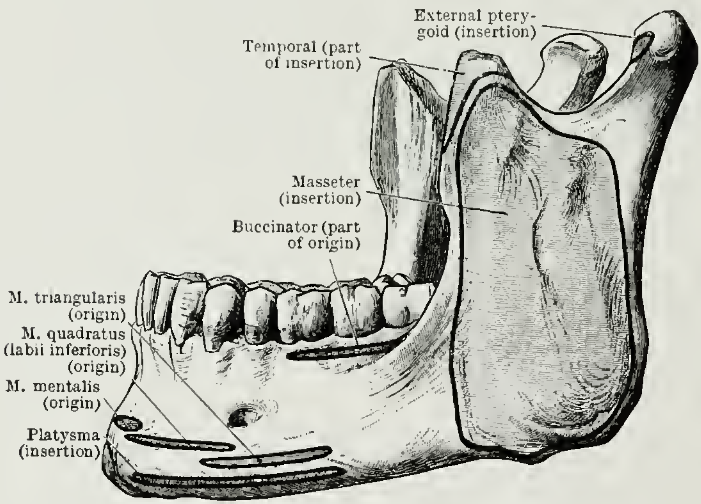


FIG. 13.—The external surface of mandible, showing muscular attachments. (*From Cunningham.*)

the frontal, ethmoid, superior maxillary, and its companion nasal bone. No muscles are attached to it.

The two maxillary bones form the upper jaw. The body of this bone is made hollow by the maxillary sinus, or antrum of Highmore, which opens into the middle meatus of the nose. It supports four processes: the malar, the nasal, the alveolar for

the sockets of the upper teeth, and the palatine, which forms the front part of the roof of the mouth. It enters into the construction of the orbit, the nose and the mouth. On the anterior or facial surface are seen the incisive and canine fossae, separated by the canine eminence, the infra-orbital foramen, and a part of the lower margin of the orbit. The posterior surface is marked by the posterior dental canals, the maxillary tuberosity and half of the posterior palatine canal. The orbital, or superior surface, forms part of the floor of the orbit, and is grooved by the infra-

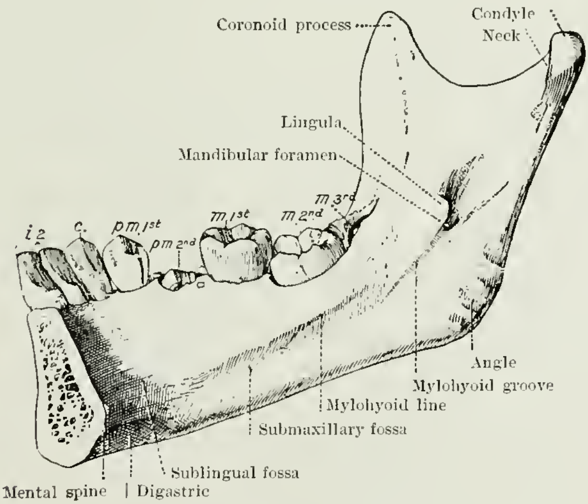


FIG. 14.—Internal surface of mandible. (*From Dixon.*)

orbital canal for the nerve and vessels of that name. The internal, or nasal surface, shows, above the palate process, the opening of the antrum, half the lachrymal duct, the inferior turbinated crest for the inferior turbinated bone, and above this, on the nasal process, the superior turbinated crest for the middle turbinated bone.

Below these crests are spaces called the inferior and middle meatuses of the nose. The antrum has its orifice much diminished, when the bones are articulated, by the ethmoid, inferior turbinated and palate bones. The malar process joins the maxillary process of the malar bone; the nasal process ascends along-

side of the nasal bone, and is grooved by half of the lachrymal duct. The alveolar process has eight cavities for the two incisors, one canine, two bicuspid, and three molar teeth. The palate process constitutes a great portion of the roof of the mouth and of the floor of the nose; it is perforated by the anterior palatine canal, and in front projects to form the anterior nasal spine. It articulates with frontal, ethmoid, nasal, malar, lachrymal, inferior turbinated, palate, vomer and the companion superior maxillary. The muscles of importance attached to it

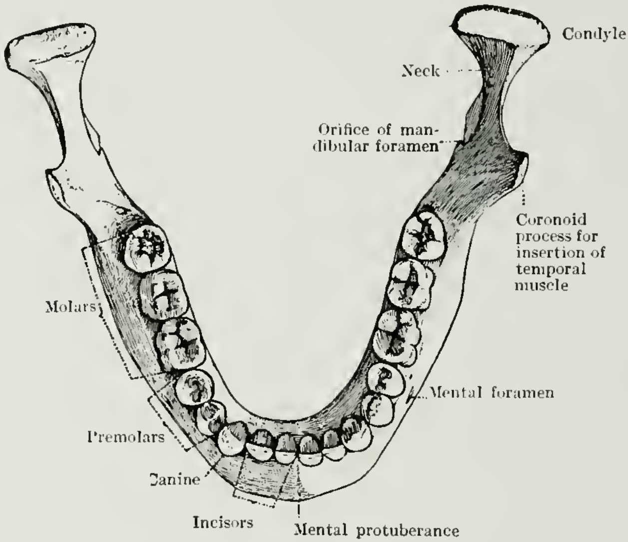


FIG. 15.— Superior surface of mandible. (*From Dixon.*)

are: Orbicular of eyelids, elevator of the upper lip, elevator of the lip and nose, elevator of the angle of mouth, masseter, buccinator, and orbicular of mouth.

At the inner side of each eye socket is the thin scale-like bone called lachrymal. It shows the lachrymal groove for the lachrymal sac, and articulates with frontal, ethmoid, superior maxillary and inferior turbinated. The tensor muscle tarsus has its origin from its orbital surface.

The zygomatic, or malar, bone has frontal, zygomatic, maxillary and orbital processes, and is perforated by the temporomalar

canals. It articulates with frontal, sphenoid, temporal and superior maxillary. The muscular attachments are elevator of the upper lip, greater and lesser zygomatics, masseter and temporal.

The palate bone, situated at the back of the nose and mouth, is shaped like the letter L, having a vertical and a horizontal plate. The horizontal plate forms the back part of the hard palate, and therefore serves as the floor of the nose in the posterior part of that cavity. Its anterior edge articulates with the palate process of the maxilla or upper jaw bone, its internal with

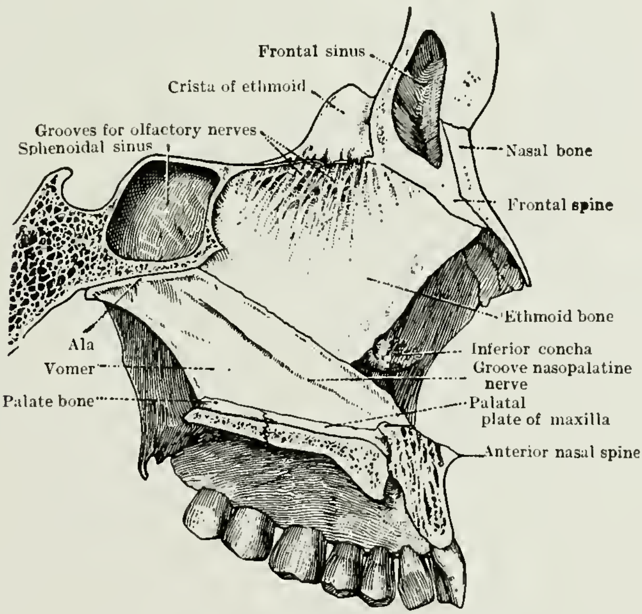


FIG. 16.— Section of maxilla and cranial bones to show chrondro-osseous septum of nose. (*From Dixon.*)

that of the opposite palate bone; its external joins the vertical plate of its own palate bone, while the posterior is free for the attachment of the soft or muscular palate. In the middle line the two plates unite to form the posterior nasal spine. The vertical plate, on its nasal surface, has ridges, called the inferior and superior turbinated crests, for the inferior and middle turbinated bones, resembling in this respect the inner surface of the

superior maxilla. Below these crests are the inferior and middle meatuses of the nose. The anterior part of this plate is prolonged as the maxillary process, which covers parts of the opening of the antrum; at the back part is seen the posterior palatine canal. At the junction of the horizontal and vertical plates of the palate bone posteriorly is situated the tuberosity, or pterygoid process, of the palate, which fits into the notch between the two pterygoid plates of the sphenoid. The middle portion of the vertical plate forms the sphenoidal process, at the base of which

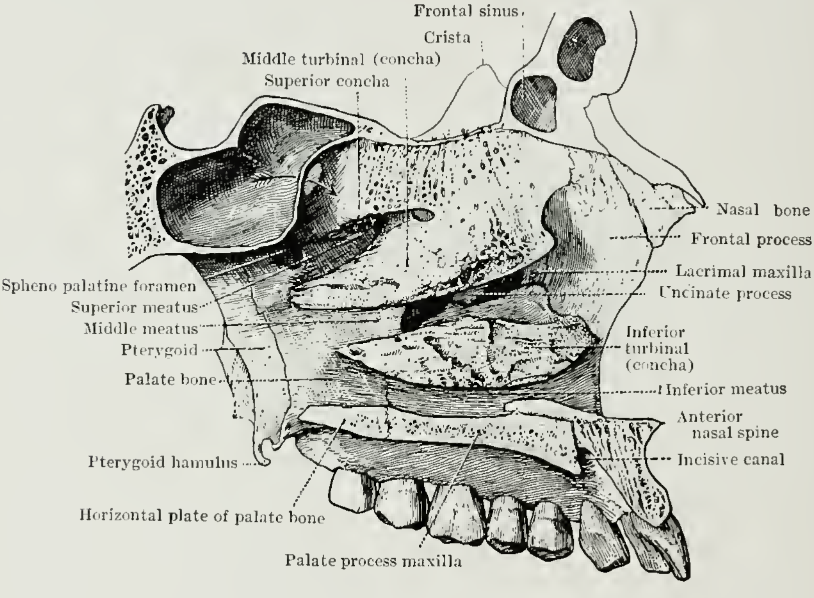


FIG. 17.—Internal surface of maxilla and turbinal bones. (*From Dixon.*)

is the spheno-palatine foramen separating it from the orbital process above. The orbital process consists of a five-sided projection containing a cavity or sinus in its interior. The surfaces are named maxillary, sphenoidal, and ethmoidal, because they articulate with these bones; and orbital and zygomatic, because looking toward these cavities. The palate articulates with sphenoid, ethmoid, superior maxillary, inferior turbinated, vomer and opposite palate bones. The azygos of the uvula, tensor of

palate, internal and external pterygoid and superior constrictor muscles of the pharynx are attached to it.

The inferior turbinated bone lies within the nasal fossa, and is curled or scroll-shaped. It has a lachrymal, a maxillary and an ethmoid process, and articulates with the lachrymal, superior maxillary, ethmoid and palate. It is covered by the nasal mucous membrane.

The bony septum of the nose is formed to a great extent by the vomer, which has a shape like a plough-share. Its base has

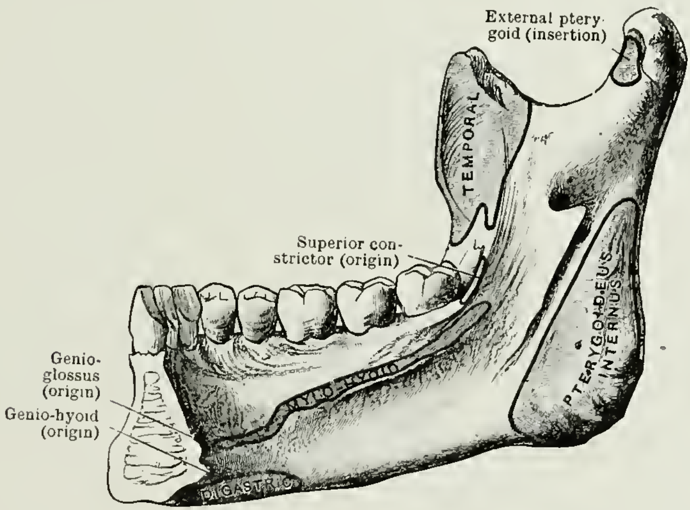


Fig. 18.—The internal surface of mandible showing muscular attachments. (*From Cunningham.*)

two alae, or wings, which articulate with the sides of the rostrum of the sphenoid; along each side of the bone is a groove or canal for the naso palatine nerve. Its articulations are with the sphenoid, ethmoid, two superior maxillary and two palate bones, and with the triangular cartilage of the nose.

The mandible, inferior maxillary or lower jaw bone is really two bones united at the chin; hence each half is symmetrical. It carries the lower teeth which correspond in name and number with those of the upper jaw, formed of the two superior maxillary bones. In military parlance the thirty-two teeth contained

in the upper and lower dental arches are given numbers for identification.

The mandible is composed of the body, or horizontal horseshoe shaped portion, and a perpendicular portion, or ramus, on each side. The body presents in front the mental process and the symphysis; and laterally the incisive fossa, the mental foramen, the external oblique line and the groove for the facial artery. On the inner surface of the body are seen the genial tubercles, fossa for the sublingual gland, depression for digastric muscle, internal oblique line, or mylo-hyoid ridge, and fossa for submaxillary gland. The alveolar border of the body contains the sockets for the teeth.

In the child there are on each side, 2 incisors, 1 canine, 3 molars; in the adult, 2 incisors, 1 canine, 2 bicuspids and 3 molars. The ramus, or vertical portion, has at its upper border the condyloid process, for articulation with the glenoid cavity of the temporal muscle, and the sigmoid notch between. On its internal aspect are seen the aperture of the inferior dental canal, the mylo-hyoid groove for the vessels and nerve of that name, and the spine for the internal lateral ligament of the temporo-maxillary joint. The angle of the jaw to which the stylo-maxillary ligament is fastened is made by the junction of the ramus and body. The lower jaw is developed by two lateral ossific centers, and articulates on each side with the temporal bone.

Many muscles are fastened to this bone. The muscles of the lips are the elevator and the depressor of lower lip, depressor of angle of mouth, platysma myoid, orbicular of mouth. These have their origins from the bone and are inserted especially into the soft tissues forming the lips.

The muscles of mastication are the buccinator, masseter, internal and external pterygoid, temporal, digastric, genio-hyoid, mylo-hyoid, geni-hyo-glossus. The muscles have for their functions opening and closing the jaws so as to cut, mash and grind food and to hold the food between the teeth.

Certain changes in the shape of the lower jaw occur during the periods of life from youth to old age. These are due to the fact that when the full number of permanent teeth are in position the alveolar process must be deep, to support them firmly. Hence, in infancy, and old age the mental foramen is near the upper edge

of the body, because there is no marked alveolar process. In the same way, the angle made by the axis of the ramus and the axis of the body is obtuse, because the jaws are not separated by the teeth. In adult life the alveolar process is high in both jaws, and the bone shows nearly a right angle between body and ramus. The loss of the teeth from disease, accident, or advancing years

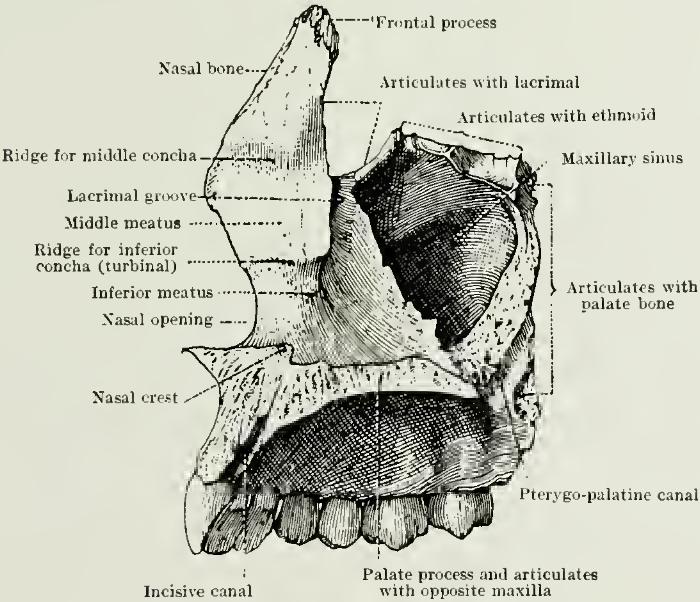


FIG. 19.—Inner side of maxilla. (*From Dixon.*)

gives rise to atrophy; the mandible becomes a more delicate structure where the loss has occurred. The angle between body and ramus becomes more obtuse in aged persons; especially if all the teeth have been lost and no artificial denture has been employed as a substitute. A tooth in one jaw, having no opponents in the other jaw, usually increases in length because it has no opposite tooth against which to strike.

The surgeon must recollect that retention of some of the deciduous teeth may exist in adult life, and that some of the adult teeth may remain non-erupted or impacted within the maxillae or the mandible. The x-ray has shown the existence of several

non-erupted teeth in the same jaw. Sometimes these teeth grow upward or laterally and fail to effect their escape because of lack of space between teeth previously extruded. Such impaction may be the cause of neuralgia and other conditions. Operations for the removal of impacted teeth causing neuralgia or dental deformity are often required.

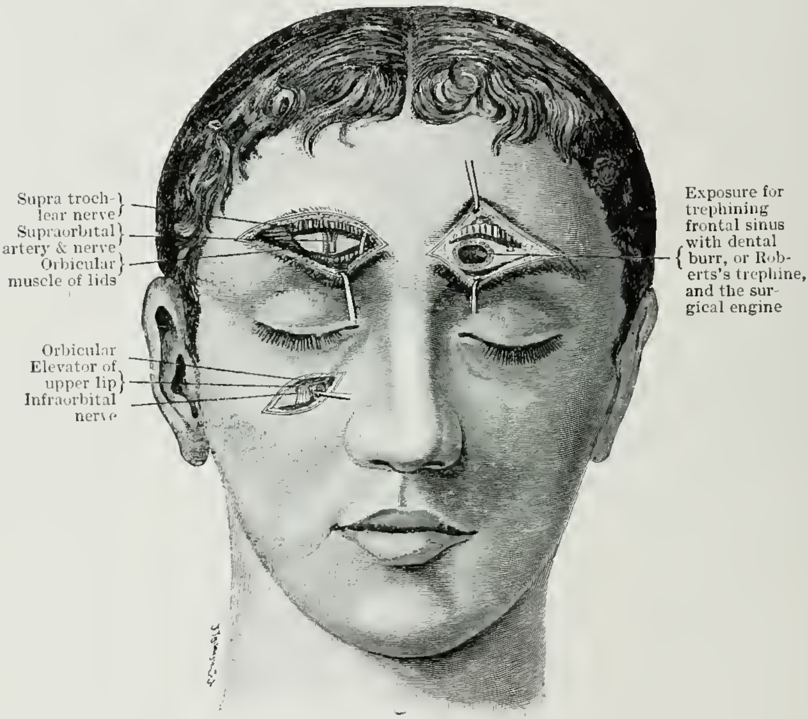


FIG. 20.—Exposures for opening frontal sinus and for neurectomy of supraorbital and infraorbital nerves. (*From Kocher.*)

ARTERIES OF THE HEAD AND NECK.

War causes such serious wounds of the neck and head, and infection such likelihood of secondary bleeding that a knowledge of the vascular supply and venous drainage of the face is a requisite of good surgery. Plastic repair of facial deformity depends greatly on the selection and maintenance of a proper

anastomosis of blood channels. For these reasons the situation of the main arteries and veins must be kept in mind.

The innominate and common carotid arteries on the right side of the neck and the common carotid on the left side supply the blood of the face and front of the neck. The innominate artery arises from the summit of the aortic arch, and proceeds to the

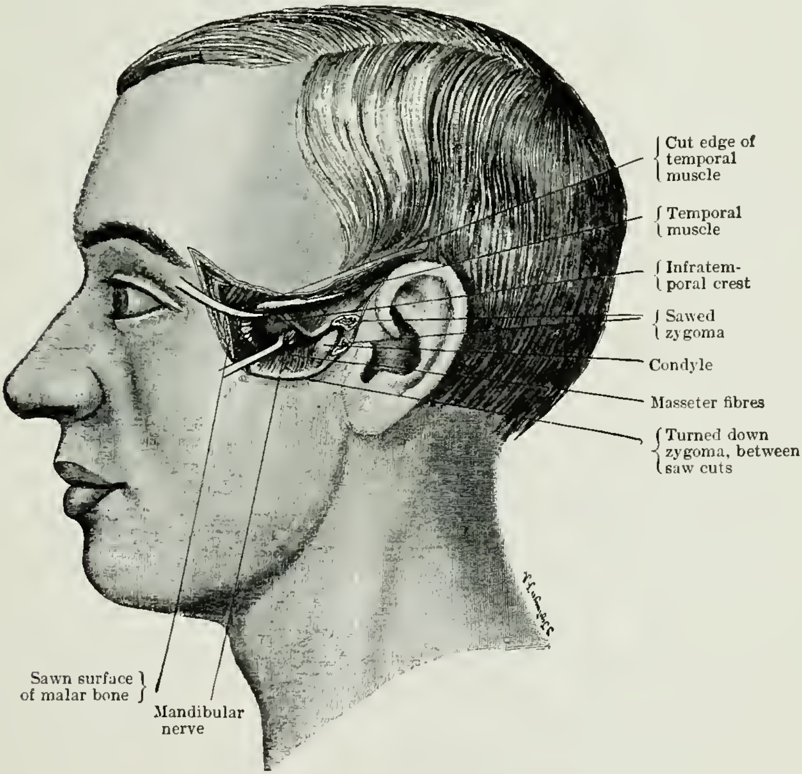


FIG. 21.— Exposure of mandibular nerve at oval foramen. (*From Kocher.*)

right sterno-clavicular junction, where it divides into the right common carotid and right subclavian. The left common carotid and the left subclavian arise directly from the arch of the aorta.

The common or primitive carotid arteries of the two sides of the neck have a different origin, but their branches and distribution are similar, because the left carotid after it reaches the left

sterno-clavicular junction, is then identical in course and branches with the right. A line, drawn, from the sterno-clavular articulation to a point midway between the mastoid process and angle of the lower jaw, indicates the course of the vessel, which bifurcates, however, into the external and internal carotids at the level of the top of the thyroid cartilage of the larynx. The artery is crossed about the middle of its course by the omo-hyoid muscle, and lies under the inner border of the sterno-mastoid muscle. In the sheath of the artery are enclosed the internal jugular vein, on the outer side, and the pneumogastric nerve behind in the groove between the artery and veins. On the front surface of the sheath lies the descending branch of the hypoglossal nerve. The common carotid has no branches except the terminal ones already mentioned, of which the internal carotid is the one further from the median line.

The external carotid artery is so called because it supplies the external portion of the head, and not because of its location in regard to the other artery, which, though external in situation, is called the internal carotid, because it supplies the interior or the cranium. The external carotid extends from the bifurcation of the common carotid, at the top of the larynx, to the neck of the condyle of the lower jaw; here it terrminates by dividing into the temporal and the internal maxillary arteries. Its course is a continuation of the line of the common carotid artery.

The branches of the external carotid are eight, as follows:

1. Superior thyroid, given off below the hyoid bone and going to the upper part of the thyroid gland. Its important branches are superior laryngeal, hyoid, crico-thyroid, sterno-mastoid.

2. Lingual, which runs under hyoglossus muscle, and has as branches the hyoid, sublingual, dorsal of tongue, ranine.

3. Facial, crosses lower jaw in front of masseter, of which there are as branches in cervical region and in facial region the ascending palatine, tonsillar, inferior labial, submaxillary, inferior coronary, submental, superior coronary, lateral nasal, angular.

4. Occipital, passing beneath digastric and lying in groove under mastoid process. Its branches are muscular, principal of neck (princeps cervicis), auricular, cranial, inferior meningeal.

5. Posterior auricular, ascends through parotid gland behind auricle with its styloid mastoid, and auricular branches.

6. Ascending pharyngeal, lies on greater anterior rectus muscle of head and ascends to base of the skull. The branches are called external, meningeal, pharyngeal.

7. Temporal, is one of the terminal branches of the external carotid. It traverses the parotid gland, crosses the zygomatic arch, and divides into anterior and posterior temporal. Its important branches are transverse facial, anterior temporal, middle temporal, posterior temporal, anterior auricular.

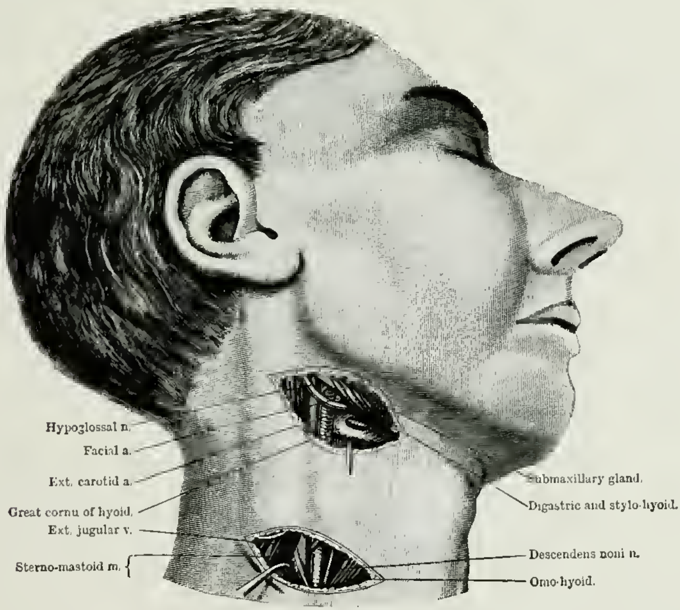


FIG. 22.—Exposure for ligation of lingual artery above great horn of hyoid bone, and ligation of common carotid at level of cricoid cartilage.
(*From Kocher.*)

8. Internal maxillary, the larger terminal branch of the external carotid is divisible into three portions according to its location in different parts of its course.

a. The maxillary portion runs directly forwards between the ramus of the jaw and the internal lateral ligament, and has the following branches. Tympanic, middle meningeal, small meningeal, inferior dental, dividing incisor and mental.

b. The pterygoid portion runs upwards and forwards upon the external pterygoid muscle and gives off the deep temporal, pterygoid, masseteric, buccal.

c. The spheno-maxillary portion lies in the speno-maxillary fossa and curves upward, usually piercing the external pterygoid muscle. Its branches are alveolar, giving off superior dental, infraorbital, posterior or descending palatine, vidian, pterygo-palatine, naso-palatine.

The teeth, then, are supplied with blood as follows: Those of the lower jaw receive blood from the first portion of the internal maxillary by the inferior dental branch, and by the incisor, its continuation. In the upper jaw, the molars and bicuspids are supplied by the superior dental branch of the alveolar, coming from the third portion of the internal maxillary, and the front teeth by small branches from the infraorbital, coming also from the internal maxillary.

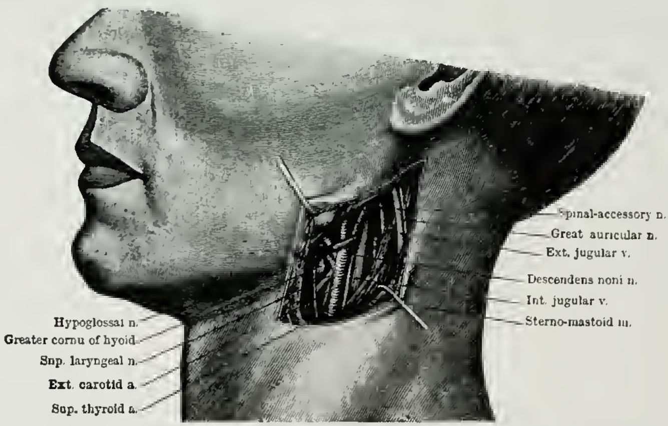


FIG. 23.— Exposure for ligation of external carotid artery. (*From Kocher.*)

The internal carotid, starting at the point of bifurcation of the common carotid, opposite the top of the larynx, ascends and enters the cranium through the carotid canal, in the petrous portion of the temporal bone. In the first, or cervical, portion of its course, the artery runs almost vertically up the neck to the petrous portion of the temporal bone. It is in relation with the

internal jugular vein and pneumogastric nerve, lying at its outer side, and with the pharynx and tonsil on its inner side. The petrous portion lies in the temporal bone and makes abrupt curves during its passage through the canal; the cavernous portion lies at the inner side of the cavernous sinus, extending to the anterior clinoid process; the cerebral portion is short and curving upwards from this point pierces the dura mater.

Branches of internal carotid are:

From (a) cervical portion, none.

From (b) petrous portion, tympanic, anterior meningeal.

From (c) cavernous portion, ophthalmic, from which lachrymal, muscular, supra-orbital, anterior ciliary, anterior ethmoidal, short ciliary, posterior ethmoidal, long ciliary, palpebral, central of retina, frontal, nasal.

From (d) cerebral portion, posterior communicating, anterior cerebral, joined by anterior communicating, middle cerebral, anterior choroid.

The circle of Willis is a name given to the anastomosis of the branches of the two internal carotid and two vertebral arteries at the base of the brain. The two vertebrals form a large trunk called the basilar, which gives off, besides other branches, two posterior cerebrals. The circle is then formed by two anterior cerebral, two middle cerebral, two posterior cerebral, two posterior communicating, one anterior communicating.

These anastomose in the following manner: The two anterior cerebrals are joined together by the anterior communicating, and the middle cerebral of each side is joined to the corresponding posterior cerebral by a posterior communicating.

VEINS OF THE HEAD.

The veins of the exterior of the head are: Facial, temporal, internal maxillary, temporo-maxillary, posterior auricular, occipital.

The facial vein, commencing as the frontal vein, runs down the forehead to the root of the nose, where the veins of the two sides are connected by the nasal arch; thence along the inner canthus as the angular; beyond which point it is the facial vein. It crosses the lower jaw just in front of the masseter muscle, and, after receiving the temporo-maxillary, empties into the

internal jugular. It receives the following branches: Supra-orbital, nasal, superior palpebral, inferior palpebral, superior labial, inferior labial, buccal, masseteric, submental, inferior palatine, sub-maxillary, ranine.

The temporal, commencing at the top of the head, runs down behind the condyle of the jaw and forms, by uniting with the internal maxillary, the temporo-maxillary vein. It is joined by middle temporal, parotid, anterior auricular, transverse facial.

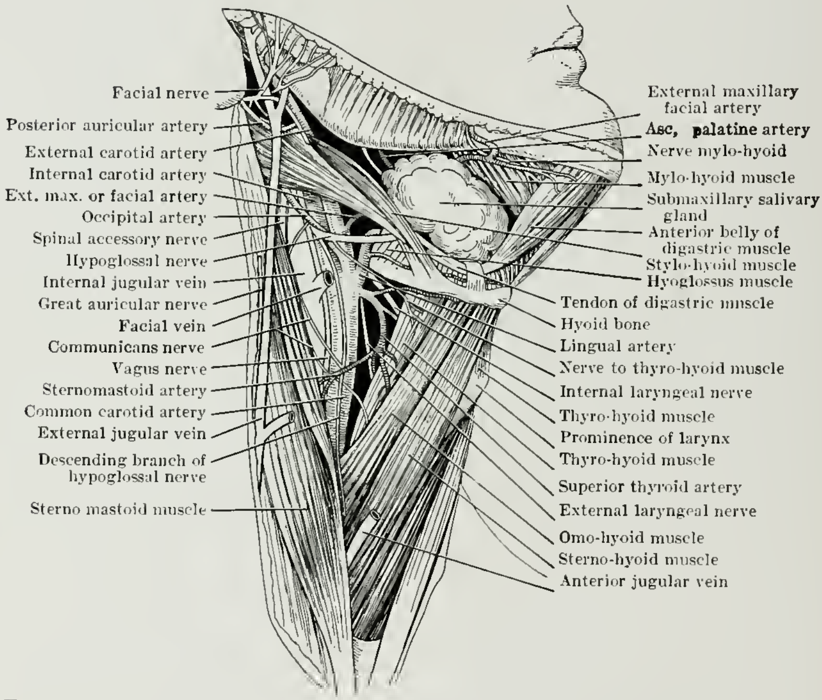


FIG. 24.—Dissection of side of neck with border of sterno-mastoid retracted (*From Beesly and Johnston.*)

The internal maxillary starts in the pterygoid plexus, formed by the junction of the several branches mentioned below, and it then unites with the temporal behind the condyle of the jaw. The branches forming the pterygoid plexus correspond with those from the internal maxillary artery, and are as follows:

Middle meningeal, deep temporal, pterygoid, masseteric, buccal, palatine.

The temporo-maxillary vein passes from the junction of the temporal and internal maxillary downwards into the parotid gland, where it divides into two branches, one joining the facial, the other the external jugular. It receives only the posterior auricular.

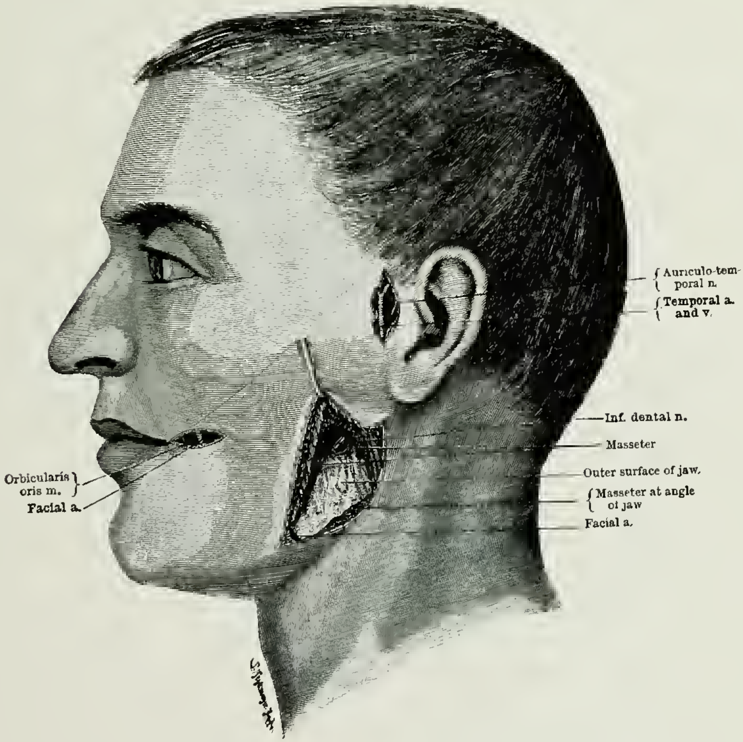


Fig. 25.— Exposure for ligating temporal artery; ligating external maxillary (facial) artery in cheek and for neurectomy of inferior alveolar nerve through a trephine opening in mandible. (*From Kocher.*)

The posterior auricular, starting upon the side of the head, runs down behind the ear and joins the temporo-maxillary to form the external jugular. It receives stylo-mastoid, branches from external ear.

The occipital, commencing just behind the vertex of the head, passes downward with the occipital artery to empty into the internal jugular. It communicates with lateral sinus by the mastoid.

VEINS OF THE NECK.

These are five in number: External jugular, anterior jugular, posterior jugular, internal jugular, vertebral.

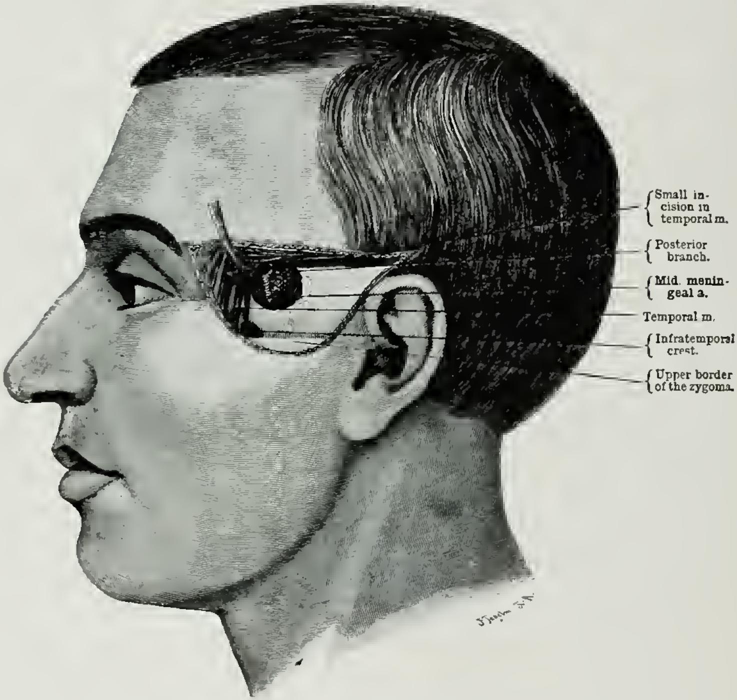


FIG. 26.—Exposure for trephining cranium and ligating the middle meningeal artery, when surgeon prefers not to make an osteoplastic resection of skull with trephine and saw. (*From Kocher.*)

The external jugular is formed by the union of the temporo-maxillary with the posterior auricular in the parotid gland, and passes downwards through the neck to empty into the subclavian. Its direction is that of a line drawn from angle of the jaw to the middle of the clavicle. The superficial cervical nerve

crosses it; and running with it at its upper part is the great auricular nerve. It has two valves, and receives posterior jugular, supra-scapular, transverse cervical.

The posterior jugular draws the blood from the upper and back part of the neck, and terminates in the external jugular a little below the middle.

The anterior jugular carries the blood from the superficial

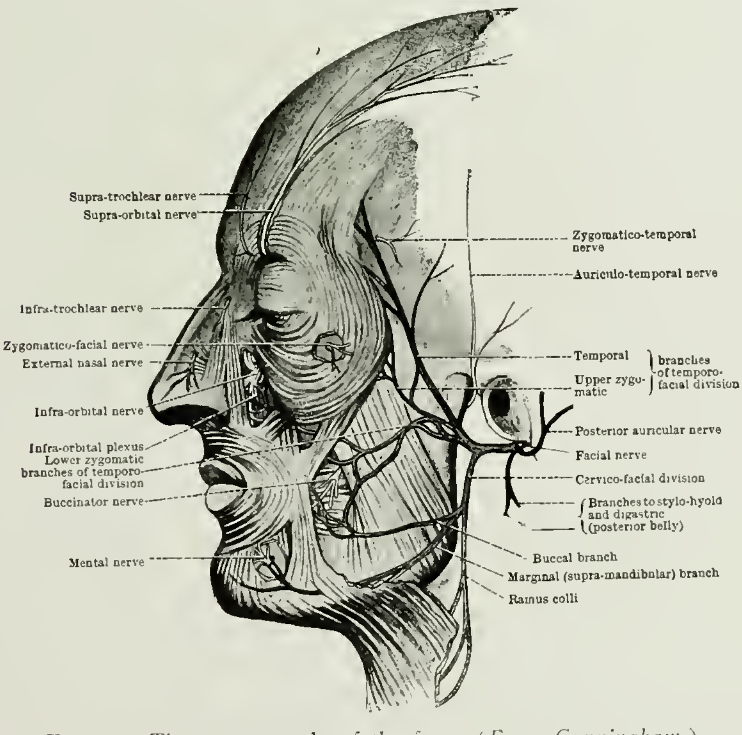


FIG. 27.—The nerve supply of the face. (*From Cunningham.*)

parts in the anterior portion of the neck, and empties into the external jugular. It has no valves.

The internal jugular, commencing at the posterior lacerated foramen, or jugular foramen, where the lateral and inferior petrosal sinuses unite, runs down the neck on the outer side of the internal and common carotid arteries, and joins the subclavian to form the innominate vein. It is accompanied by the

pneumogastric nerve, and has only one pair of valves. Its branches are facial, lingual, pharyngeal, superior thyroid, middle thyroid, occipital (previously described).

The vertebral vein collects blood from the occipital portion of the head, and runs down the side of the spinal column to open into the innominate. It does not enter the skull like the vertebral artery, but draws the blood from the exterior of the head and neck, and the interior of the spinal canal. It passes through the foramina in the transverse processes of the upper six, and, sometimes, of all the cervical vertebrae, making a bend outwards, to enter that of the atlas. It has one pair of valves and is joined by the following: Posterior condyloid, muscular, dorsi-spinal, meningo-rachidian from interior of spinal canal, ascending cervical, deep cervical.

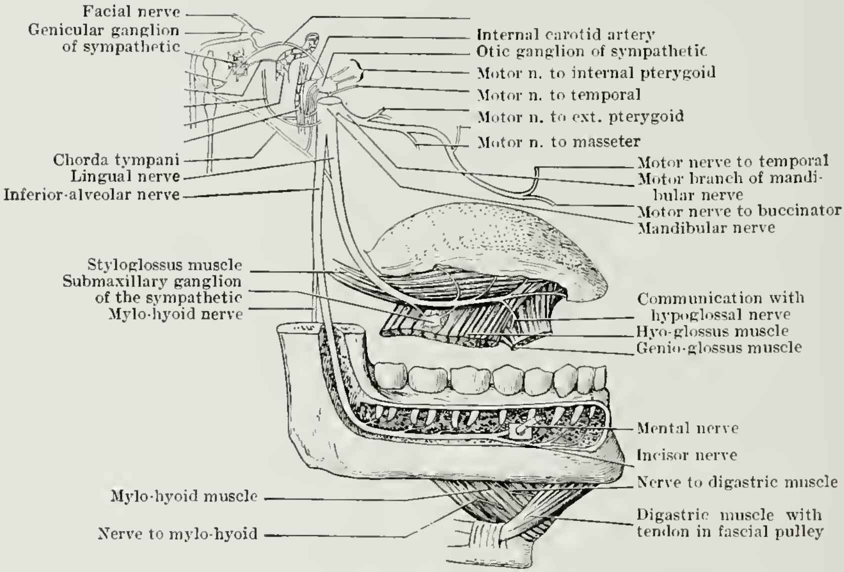


FIG. 28.— Branches of mandibular nerve. (*From Cunningham.*)

CRANIAL NERVES.

The facial structures are innervated by the cranial nerves. The neck, which is associated with the face in military and civil surgery, has its nerves partly from the cranial source and partly from nerves of spinal origin.

There are twelve pairs of cranial nerves, all of which, arising from the encephalon, make their exit through openings in the base of the skull. The function of these nerves differs. Some of them are nerves of common sensation, some are nerves of

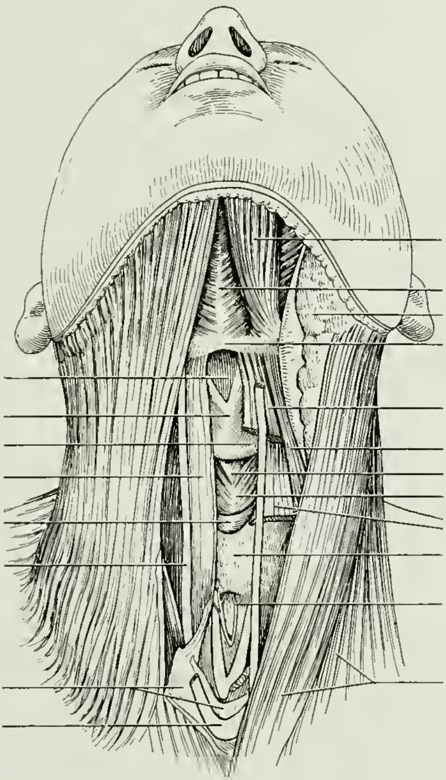


Fig. 29.— Dissection showing structures concerned in laryngotomy and tracheotomy. (*From Beesly and Johnston.*)

motion, others are nerves of special sense, while a few partake of two characters and have branches with different functions.

Number.	Name.	Function.
First,	Olfactory,	Smell.
Second,	Optic,	Sight.
Third,	Motor oculi,	Motion.
Fourth,	Pathetic,	Motion.

Fifth,	Trifacial or Trigeminal,	Sensation (large root).
		Motion (small root).
		Taste (a small branch).
Sixth,	Abducent,	Motion.
Seventh,	Facial or Portio dura,	Motion.
Eighth,	Auditory or Portio mollis,	Hearing.
Ninth,	Glosso-pharyngeal,	Sensation.
Tenth,	Pneumogastric or Parvagum,	Sensation.
		Motion.
Eleventh,	Spinal Accessory,	Motion.
Twelfth,	Hypoglossal,	Motion.

This numbering, proposed by Sömmering, is the better though some writers still adhere to the old method of Willis, who included the facial and auditory under the name of the seventh, and the glosso-pharyngeal, pneumogastric and spinal accessory under the name of the eighth. The hypoglossal then becomes the ninth.

The operative surgery of the neck and face is so much concerned with the relations and functions of these nerves that the military surgeon must have a pretty definite idea of their situation, and the results of their impairment or destruction by disease or injury.

All these cranial nerves, with the exception, perhaps, of the olfactory and optic, have branches of communication with neighboring cranial, spinal, and sympathetic nerves. It is to be observed that those whose function is common sensation have ganglia, similar to the sensory, or posterior, roots of spinal nerves. This analogy is greatest in the case of the fifth nerve, which has a small motor root without a ganglion, and a large sensory root with one. It is this sensory root which is divided or avulsed in the intracranial operation for convulsive neuralgia of the face, termed tic douloureux. The pneumogastric presents a similar character, if the spinal accessory be looked upon as its motor root.

Connected with the fifth, or trifacial nerve, are a number of sympathetic ganglia. Each ganglion has a communication, or root, with a motor, a sensory and a sympathetic nerve; and then furnishes branches to neighboring structures.

SYMPATHETIC GANGLIA CONNECTED WITH THE TRIFACIAL NERVE.

Name.	Situation.	Sensory Root.	Motor Root.	Sympathetic Root.	Distribution.
Ophthalmic or Ciliary.	Between optic nerve and external rectus.	5th Nerve; 1st division, nasal branch.	3d Nerve; branch to inferior oblique.	Cavernous plexus.	Short ciliary nerves to ciliary muscle and iris.
Spheno-palatine (Meckel's).	Spheno-maxillary.	5th Nerve; 2d division, spheno palatine branches.	7th Nerve; large petrosal and vidian.	Carotid plexus through vidian.	Anterior, middle and posterior palatine, and naso-palatine branches.
Otic (Arnold's).	Below oval foramen.	5th Nerve; 3d division, auriculo - temporal branch.	7th Nerve; small petrosal(?). (Also from internal pterygoid branch of 3d division of fifth.)	Middle meningeal plexus.	To tensor of palate and tensor of tympanum.
Sub-maxillary.	Above sub-maxillary gland.	5th Nerve; 3d division, lingual branch.	7th Nerve; chorda tympani.	Facial plexus.	To sub-maxillary gland, mucous membrane of mouth.

SPINAL NERVES.

The upper spinal nerves are so closely associated with the cranial nerves in operations involving the neck and face that they deserve attention.

Nerves arising from the spinal cord are arranged in pairs; and

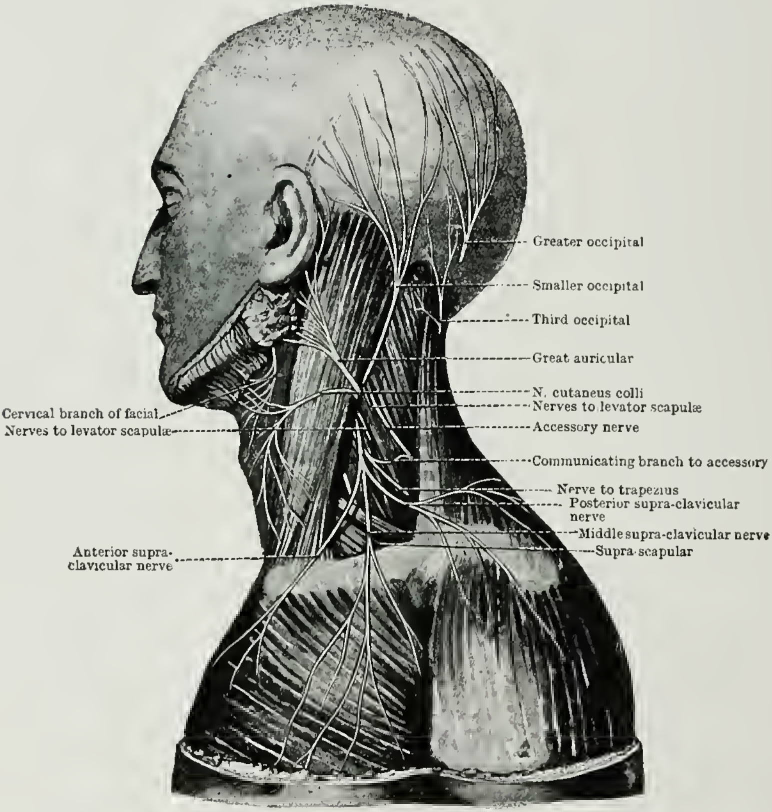


FIG. 30.—Nerve supply of the neck. (*From Cunningham.*)

each one has two roots, a posterior, or sensory, and an anterior, or motor. The posterior is the larger, and has upon it a ganglion. The ganglion of the first cervical is frequently absent. After the roots unite, the nerves, having now both sensory and motor fibers, make their exit through the intervertebral

foramina. Immediately each one divides into a small posterior branch and a large anterior branch. These branches must not be confused with the anterior and posterior roots of spinal nerves, already described. The posterior branches supply the back of the trunk, the anterior ones the neck, the sides and front of the trunk and the extremities.

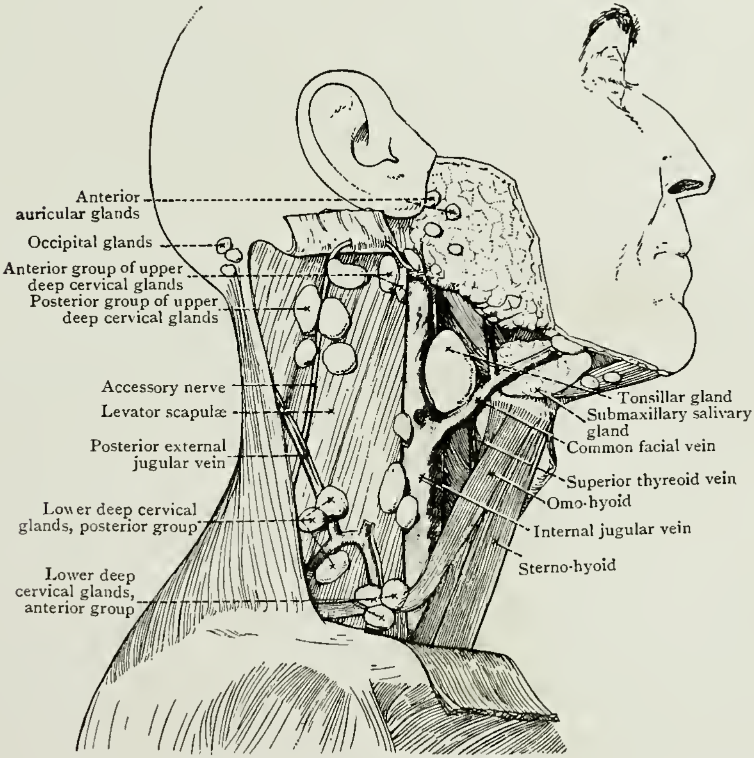


Fig. 31.—Dissection exposing deep veins and lymph nodes of the side of neck. Sterno-mastoid muscle divided and retracted.
(*From Beesly and Johnston.*)

There are thirty-one pairs of spinal nerves: Cervical, 8 pairs; dorsal, 12 pairs; lumbar, 5 pairs; sacral, 5 pairs; coccygeal, 1 pair; total, 31 pairs.

There are eight cervical nerves, because the first one, sub-occipital, makes its exit above the first, and the last below the

seventh cervical vertebra. The posterior branches of the spinal nerves are small and as a rule unimportant; the anterior in the upper and lower regions unite to form symmetrical plexuses on both sides of the median line, from which large and important trunks are given off.

The plexuses are as follows: Cervical, from anterior branches of four upper cervical; branchial, from anterior branches of four cervical and first dorsal; lumbar, from anterior branches of four upper lumbar; sacral, from anterior branches of four upper sacral and last lumbar (with part of fourth lumbar).

These plexuses have communicating branches with the adjacent plexuses, so that inter-communication is established throughout.

CERVICAL NERVES.

The anterior branches of the first four cervical nerves on right and left side of the neck unite to form a cervical plexus, while the last four with the first dorsal form the brachial plexuses.

The cervical plexus, which is formed from the anterior branches of four upper cervical nerves, has superficial and deep branches.

Its superficial branches are:

1. Superficial cervical, to front and side of neck.
2. Great auricular, to region of ear.
3. Small occipital, to back of head and and occipito-frontal.
4. Supra-clavicular, to front of chest and shoulder.

Its deep branches are:

1. Communicans noni, to descending branch of hypoglossal.
2. Phrenic, to diaphragm. Arises from third, fourth and fifth nerves, runs in front of anterior scalene muscle, and alongside of pericardium.
3. Muscular, to cervical muscles.

The posterior branches of the cervical nerves have no important branches of distribution, except the second, which gives off the great occipital, to supply the scalp.

CHAPTER III.

ANATOMY OF THE MOUTH AND ORGANS OF SPECIAL SENSE.

The mouth is an oval opening, the entrance to the buccal cavity. In that cavity the food is masticated or chewed, prior to being carried into the stomach by the act of swallowing. The term mouth is often, perhaps usually, considered to include the cavity between the cheeks which are its lateral walls. It is bounded by lips, cheeks, jaws, palate and tongue, and opens posteriorly into the pharynx. The lining mucous membrane is continuous with that of the pharynx and œsophagus.

The teeth are imbedded in the alveolar processes of the two maxillae and the mandible. They are surrounded by the gums, which are composed of fibrous tissue covered with mucous membrane of slight sensibility. There are two sets of teeth: the temporary, or milk, teeth of childhood; and the permanent, which appear after the shedding of the milk teeth and last during the greater part of adult life. The temporary teeth are ten, the permanent sixteen in number in each jaw; which makes in both jaws twenty temporary and thirty-two permanent teeth. The teeth in each half of the upper jaw and the mandible:

Temporary, incisors, two; canine, one; molars, two.

Permanent, incisors, two; canine, or cuspid, one; bicuspids, or premolars, two; molars, three.

All teeth have a crown, or body, which is the portion seen above the gum; a root inserted into the socket in the jaw; a neck, or constriction, between the crown and the root. A vertical section of a tooth shows a cavity in the interior, called the pulp cavity, which is continuous with an orifice in the apex or point of the root. Vessels and nerves enter the pulp cavity by this small apical aperature. The main portion of the tooth consists of dentine, which is composed of tubes, lying in the intertubular tissue. The tubules open into the pulp cavity and contain prolongations of the pulp tissue, called dentine fibers. The dentine forming the crown is covered by a layer of very hard and compact tissue, called enamel; while the root is in a similar

way covered by a layer of bone-like material, called the cement or crusta petrosa.

The temporary teeth are smaller than the permanent, but similar in structure. There are five in each half of each jaw, namely: two incisors, one canine, two molars. The molars occupy the positions subsequently filled by the bicuspids of the permanent set.

Of the thirty-two permanent teeth, the incisors have a sharp cutting edge, and are situated in the front of the dental arch. They number four in each jaw, their function is to cut food. The canine are placed one on each side of the incisors, thus making two in each jaw, and have a conical pointed crown adapted to tearing food. The upper canines are popularly known as eye teeth, the lower as stomach teeth. There are two bicuspids also called premolars, situated behind each canine. They have two eminences, or cusps, on the grinding surface of the crown, and the roots, though single, like those of the teeth already described, show a tendency to bifurcation at the extremities, and are grooved by a line, as though the separation into two roots had not been completed. The molars, the largest teeth, are the most posterior, and number three on each side of each jaw. They have large crowns, divided into four or five cusps, or points, and are the grinding teeth. The root consists of from two to five long processes, each of which has an opening at the apex for the entrance of vessels and nerves. The most posterior molars are called wisdom teeth.

The eruption of the temporary teeth begins at the age of seven months, and is finished when the child is two or two and a half years old. The teeth in the lower jaw usually show themselves before the corresponding ones of the upper jaw. The permanent teeth make their appearance between the sixth and twenty-first year; and those of the lower jaw usualy manifest themselves before their antagonists of the upper jaw.

The time of eruption of the two sets is approximately this:

Temporary, central incisors, 7 months; lateral incisors, 7 to 10 months; anterior molars, 12 to 14 months; canines, 14 to 20 months; posterior molars, 18 to 36 months.

Permanent, first molars, 6½ years; central incisors, 7 years;

lateral incisors, 8 years; first bicuspids, 9 years; second bicuspids, 10 years; canines, 11 to 12 years; second molars, 12 to 13 years; third molars, 17 to 21 years. In the army, the teeth are designated by numbers:

Right	Mid-line	Left
8, 7, 6, 5, 4, 3, 2, 1,		1, 2, 3, 4, 5, 6, 7, 8,
16, 15, 14, 13, 12, 11, 10, 9		9, 10, 11, 12, 13, 14, 15, 16

THE PALATE.

The hard palate, consisting of the palate processes of the superior maxillary and palate bones, and covered with mucous membrane, forms the roof of the mouth and the floor of the nose. The soft palate, formed of muscles and fascia covered by mucous

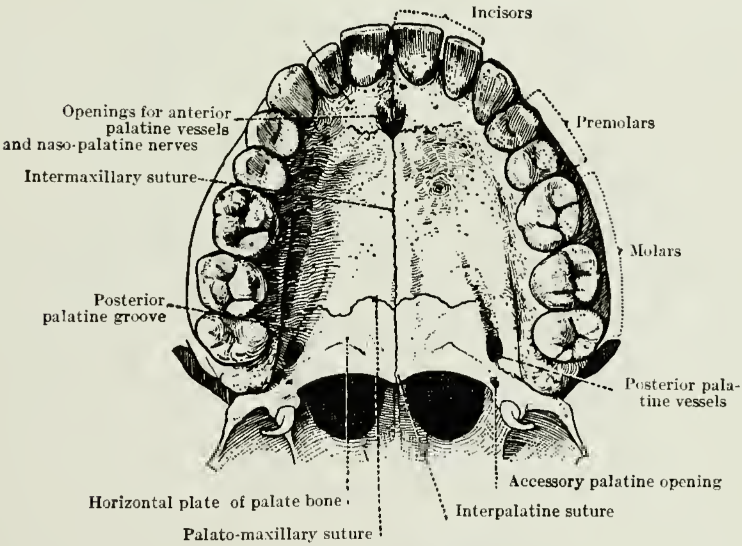


Fig. 32.—Inferior surface of maxillae and palate bones. (*From Dixon.*)

membrane, hangs from the posterior edge of the hard palate. At the middle of its free border is a pendulous process, called the uvula; on each side of which are seen two crescentic folds, or arches, of mucous membrane, stretching over to cover the palato-glossus and palato-pharyngeus muscles. These folds and projecting muscles form the anterior and posterior pillars of the palate, sometimes called pillars of the fauces. Between them on each side lies the tonsil gland, presenting a dozen small follicles.

SALIVARY GLANDS.

These glands, situated about the mouth, furnish saliva in large quantity during the process of mastication; some fluid also is secreted during the intervals between the times of taking food. Their structure is conglomerate; that is, they consist of many small lobules united together to form larger lobes. The three salivary glands are named, parotid, submaxillary, and sublingual.

The parotid lies in front of and below the ear, extending from the zygoma down to the level of the angle of the lower jaw. The external and carotid artery, as it ascends, is surrounded by it, and the facial nerve passes through it transversely. Just below

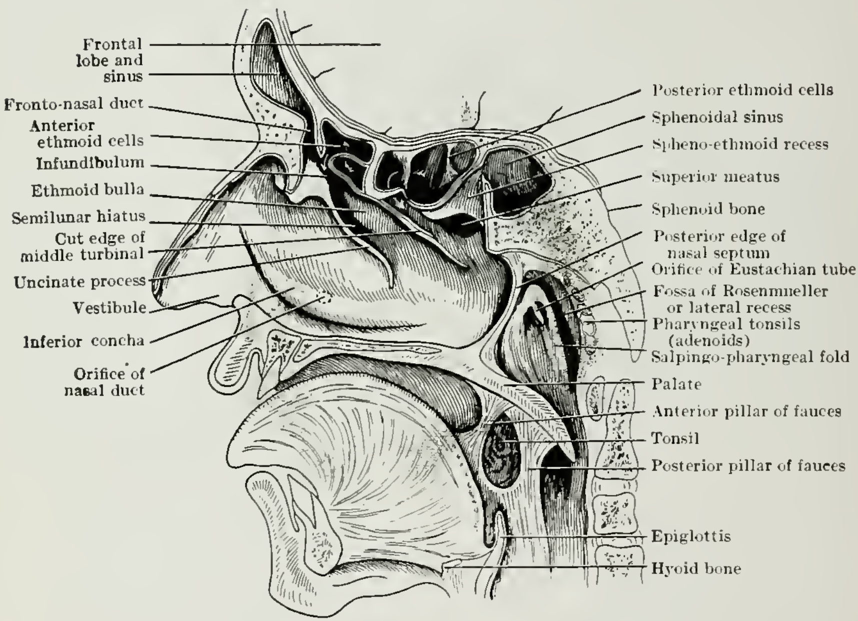


FIG. 33.— Sagittol section through nose and mouth.
(*From Macewen, modified from Turner.*)

the zygoma and lying on the masseter muscle is seen a detached lobe of the gland, called socia parotidis (associate of the parotid). The duct of the parotid, called Stenson's duct, is two and a half inches long, and opens into the mouth upon the inside of the cheek, opposite the second molar tooth of the upper jaw. It corresponds, in direction, with a line drawn from the base of the

lobule of the ear to the middle of the upper lip. The submaxillary gland lies under the lower border of the lower jaw, in the submaxillary triangle, and is separated from the parotid by the stylo-maxillary ligament, and from the sublingual by the mylohyoid muscle. The facial artery is imbedded in it. The duct, named after Wharton, opens alongside of the frenum of the tongue.

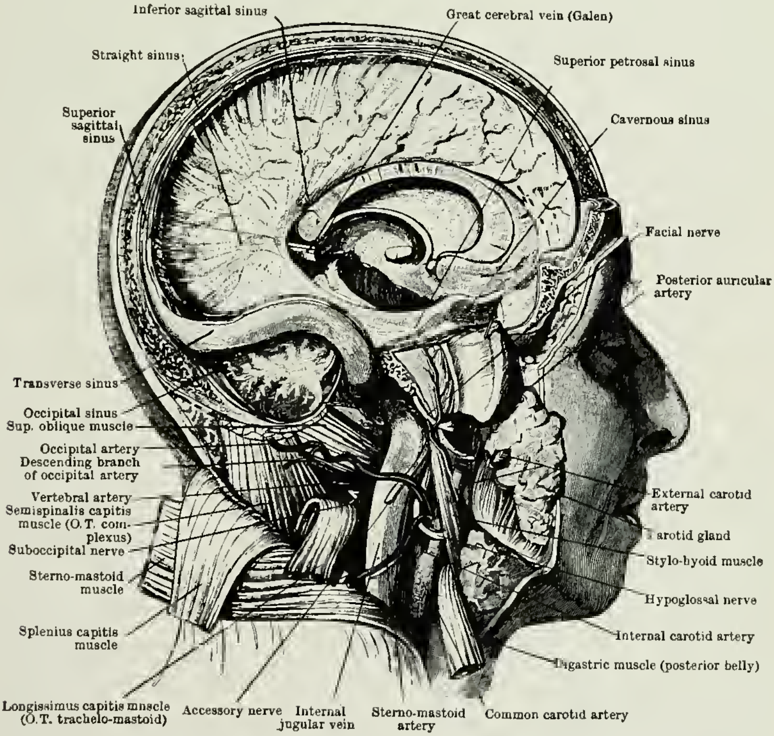


FIG. 34.—Deep anatomy of post-mandibular region and of cranium. (*From Cunningham.*)

Under the mucous membrane of the floor of the mouth, close to the inside of the symphysis of the jaw, is found the smallest of the salivary glands, the sublingual. It has ten to twenty small ducts, called the ducts of Rivini; some of which open separately alongside of the frenum, while others join together, forming the

duct of Bartholine, which connects with the duct of the submaxillary gland, already mentioned as Wharton's duct.

PHARYNX AND ŒSOPHAGUS.

The pharynx is a dilatation of the upper part of the œsophagus, and extends from the basilar process of the occipital bone to the level of the cricoid cartilage and fifth cervical vertebra. It has opening into it the two posterior nostrils, the two Eustachian tubes, the mouth, the larynx and the œsophagus.

The œsophagus is the continuation of the pharynx, and is a tube, about nine inches in length, extending to the cardiac end of the stomach. It is situated in the posterior mediastinum, in front of the vertebral column, and behind the trachea and great vessels. There is an opening in the diaphragm for its passage to the stomach. The œsophagus has an external coat, composed of circular and longitundinal muscular fibers, a middle coat of cellular tissue, and an internal mucous coat. The upper part of pharynx behind the nose is termed the naso-pharynx.

TONGUE.

The tongue is the organ of taste, and participates in handling the food within the mouth and in the production of sounds in speech. It lies within the mouth, occupying the space above the mylo-hyoid muscle and encircled in front by the arch of the mandible. It has a base or root, a body, and a point or tip. Its root is attached to the hyoid bone by numerous muscles, to the epiglottis by three folds of mucous membrane (glosso-epiglottic ligaments), and to the palate and pharynx by the pillars of the fauces. The inferior surface is fastened to the inside of the lower jaw at the symphysis by the genio-hyo-glossus muscles, and by the mucous membrane forming the frenum. The tongue is composed of muscles covered by mucous membrane which exhibits a median raphe on top of the organ. This membrane consists, like skin, of a cutis with papillæ, and an epithelial layer on top. There are three varieties of these papillæ: 1, the circumvallate or largest; 2, the fungiform; 3, the filiform or smallest. The circumvallate papillæ are about ten in number, and are arranged at the back of the dorsal surface of the tongue, like a letter V with the apex directed backwards; at the point of the V there

is a depression called the foramen caecum. The fungiform papillæ are scattered over the organ, but are especially seen at the tip and sides. They are deep red in color. The filiform are very small and numerous, and at the back are placed in lines parallel to the circumvallate papillæ, but near the tip become more irregular in their arrangement. In the circumvallate, and in some of the fungiform, papillæ flask-shaped bodies, called taste corpuscles, have been described. The surface of the tongue is supplied with mucous glands and scaly epithelium. In the back of the tongue is the lingual tonsil, similar in structure to the faucial tonsils on each side of the throat and the adenoid structures on the posterior pharyngeal wall.

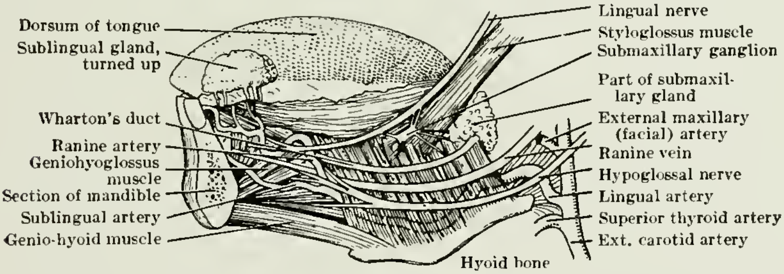


FIG. 35.—Dissection left submaxillary region. *(From Macewen, after Buchanan.)*

NOSE.

The organ of the sense of smell is the nose, consisting of the external prominence, known as the nose proper, and the two nasal fossae, or cavities, separated by a median wall, the septum. The root of the nose is attached to the forehead; the base is attached to the upper lip, and presents two openings, the nostrils, separated by the lower end of the septum, called here the columna or columnella. The movable external sides of the nostrils are called the wings (alae) of the nose. The two sides of the nose form on top the dorsum, or bridge, while the point is denominated the lobe.

The nose proper, that is, the external portion, is formed of bones and cartilages, connected by cellular tissue, covered by skin externally, and lined by mucous membrane. The bones are the nasal and the nasal processes of the superior maxillary; the

cartilages are five, two upper lateral, two lower lateral, and the cartilage of the septum. There are usually several small sesamoid cartilages between the lower lateral cartilage of each side and the nasal process of the corresponding upper maxillary. The quadrangular cartilage of the septum lies in the middle line, below and behind the nasal bones and lateral cartilages, and fits into the notch between the perpendicular plate of the ethmoid and the vomer and palate processes of the upper jaw. It frequently deviates a little to one side, instead of lying exactly in the median line. The small muscles of the nose produce very little motion of the cartilages of the human nose.

These two cavities of the nose (choana) open in front at the anterior nostrils (nares), and communicate behind with the pharynx through the posterior nostrils. They are lined by a mucous membrane, called the pituitary or Schneiderian membrane, which is so thick that the orifices opening into the nasal fossae are greatly diminished in calibre. It is continuous with the muous membrane lining the pharynx, middle ear, and eye. The meatuses and the boundaries of the nasal fossae have been described under the bones of the head.

EYE.

The eye is the organ of vision, and is contained in a conical cavity called the orbit. It is spherical in shape, with a segment of a smaller sphere placed in front. The optic nerve enters the back of eyeball a little to the inner side. The eye consists of three coats, containing refracting media called humors. The three coats are: Schlerotic and cornea; choroid, iris, ciliary muscle and processes; retina.

The humors are: Aqueous; crystalline lens and capsule; vitreous.

The sclerotic is a strong, white, fibrous coat, which gives shape and protection to the eyeball; to it are attached the muscles which move the eye. The inner surface of the sclerotic is brown in color and attached to the outside of the choroid by a layer of connective tissue, called the lamina fusca. Through the posterior portion of this coat, a little to the nasal side, the fibers of the optic nerve enter, giving at the point of entrance a sieve-like appearance. This sieve-like fascia is called the lamina cribrosa,

and has at its center an opening larger than the rest, called the porus opticus, which transmits the central artery of the retina. In front the sclerotic overlaps the cornea, with which it is continuous.

The cornea is transparent and occupies the front of the ball, projecting like a watch crystal set in the case of a watch. The cornea is made up of five layers. The central layer is of fibrous tissue, in front of which is an elastic layer, covered by mucous membrane (the epithelial layer of the conjunctiva); behind the central layer is a posterior elastic layer, and behind it the serous membrane of Descemet.

The second coat is formed by the iris and ciliary processes in front, and the choroid behind. The ciliary muscle and ligament are situated at the point where the sclerotic, and cornea, choroid, and iris come together.

The choroid is the vascular and pigmented coat of the eye, and terminates at the ciliary ligament by being folded inwards to form the ciliary processes. It has three layers; the external is composed principally of the vorticose veins, the middle layer consists of a plexus of blood vessels and is termed the tunica ruychiana, the internal or pigmentary layer consists of cells filled with pigment granules. This last layer is believed by some to be a part of the retina. The ciliary processes are arranged around the edge of the lens behind the iris; they are seventy-five in number, and fit into folds of the suspensory ligament of the lens. They are really portions of the middle and internal layers of the choroid which have been turned inward.

The iris is the colored muscular curtain suspended in the aqueous humor in front of the lens, with an aperture in it called the pupil. Its circumference is attached to the choroid and the ciliary ligaments. Its posterior surface is covered with purplish pigment named the uvea. The iris consists of fibrous tissue, pigment cells and involuntary muscular fiber; some of these fibers are circular, constituting the sphincter of the pupil, while others are radiating fibers and form the dilator of the pupil. In the fetus a delicate vascular tissue closes the pupil, constituting the pupillary membrane.

The ciliary ligament is a ring of circular fibers surrounding the iris, and joining the external and middle tunics of the eyeball.

Where it connects with the sclerotic, a small channel runs between the two, the circular sinus of the iris. The ciliary muscle surrounds the circumference of the iris near the ligament, is composed of involuntary muscular fibers, and regulates the convexity of the lens during efforts of accommodation.

The retina is the semi-transparent nervous coat upon which images are received, and lies between the choroid and the hyaloid membrane surrounding the vitreous humor. Where it terminates in front, near the ciliary ligament, it has an irregular edge called the serrated border; at its center posteriorly is the yellow spot, with a depression in its center, termed the central pit. A little to the nasal side of the yellow spot is the optic nerve entrance. The retina consists of three layers, which have, however, been sub-divided into many more. They are. External, or layer of rods and cones (Jacob's membrane); middle, or granular layer; internal, or nervous layer.

The external layer is contiguous with the choroid, the middle is composed of granules, the internal is semi-transparent, and consists of expansions of the optic nerve fibrils and of nerve cells. Between the external and middle layers is situated the external limiting membrane, between the internal layer and the hyaloid membrane of the vitreous is the internal limiting membrane.

The central artery and vein of the retina distribute branches over its surface and in its internal or nervous layer. The artery enters, and the vein makes its exit from the globe by the porus opticus in the middle of the optic nerve entrance.

The humors of the eye are the aqueous, vitreous, and crystalline lens with its capsule. The aqueous humor, which resembles water in composition, fills the space, between the cornea and crystalline lens. This space is divided by the iris into an anterior and posterior chamber. The vitreous humor, or body, enclosed in the hyaloid membrane, is between the retina and the lens; it is an albuminous fluid resembling jelly, with a depression in front, in which lies the lens surrounded by its capsule. The crystalline humor, which is a double convex lens, with an enveloping capsule, lies behind the pupil in the concavity in the front of the vitreous body, with the ciliary processes surrounding its margin. The lens is held in position by the capsule, an elastic enveloping

membrane, and by the suspensory ligament of the lens. The suspensory ligament joins the anterior edge of the retina with the front of the periphery of the lens, and there remains between this ligament and the hyaloid membrane an opening surrounding the lens, termed the canal of Petit. The lens is a transparent, double convex body, made up of concentric layers with a nucleus in the middle; it also seems to be formed by three triangular segments placed together.

The arteries of the eyeball are the short ciliary, entering around the optic nerve, and running to the middle layer of choroid and the ciliary processes; the two long ciliary arteries, lying between the sclerotic and choroid, to supply the ciliary muscle and the circumference of the iris and the margin of the pupil; the anterior ciliary branches from the ophthalmic, which enter the ball behind the margin of the cornea, to go to the ciliary processes and both margins of the iris; and finally the central artery of the retina, which has already been described.

The veins are formed from branches in the choroid, and, piercing the sclerotic, empty into the ophthalmic vein.

The nerves of the eyeball are the optic, the long ciliary from the nasal nerve, and the short ciliary from the ciliary ganglion.

APPENDAGES OF THE EYE.

The eyebrows are elevations over each orbit, supplied with hairs. The eyelids, two in number, an upper and a lower, are movable custains, or folds, to protect the front of the eye. The upper lid is the longer and more movable, and has a special muscle to lift it, the elevator of the upper lid. The external angle where the lids meet is called the external canthus; the internal angle is the inner canthus, but here the lids are separated by a little fossa, termed the lachrymal lake. At the bottom of this lake is an eminence designated the lachrymal caruncle. On the edge of each lid, at the margin of the lake, is seen a minute opening, called punctum lachrymale, which is the beginning of a lachrymal canal. The eyelid is composed of a tarsal membrane, often improperly called "cartilage," covered on the outside by the orbicular muscle and skin, on the inside by conjunctiva. Between the tarsal membrane and conjunctiva lie the meibomian glands, and on the edge of the lids are many short curved hairs,

placed in two or three rows, named eyelashes or ciliae. The conjunctiva is a mucous membrane covering the inside of the lids (palpebral portion), and the front of the sclerotic and cornea (orbital portion). Upon the cornea the conjunctiva is very thin, and scarcely consists of more than an epithelial layer; at the inner canthus it makes a semi-lunar fold termed plica semilunaris.

The lachrymal apparatus consists of the gland, canals, or canaliculi, sac and nasal duct. The lachrymal gland occupies a depression in the frontal bone at the outer angle of the roof of the orbit, and opens by ducts upon the surface of the conjunctiva in the same region. At the inner canthus the small orifices, named puncta lachrymalia, lead into minute tubes or canaliculi, which, after making a sharp turn, open into the lachrymal sac. This sac lies in a groove formed by the lachrymal bone and nasal process of the superior maxillary, and is really a dilatation of the upper end of the nasal duct. The duct is a canal three-quarters of an inch long leading through the superior maxillary bone into the inferior meatus of the nose. It will thus be seen that the tears coming from the gland at the upper and outer angle of the optic commissure must pass over the surface of the eyeball before being discharged by the canaliculi and duct into the nose.

EAR.

The function of hearing resides in the ear, which consists of three parts: the external ear, the middle ear, and the internal ear.

The external ear is composed of the auricle, or pinna, and the external auditory meatus. The auricle is an irregular concave piece of cartilage, covered by integument and attached to the margin of the bony meatus. Near the meatus it presents a deep depression called the concha; at its lower extremity is a non-cartilaginous portion, the lobule; the elevated edge or rim of the auricle is the helix, between which and the concha is another ridge called the anti-helix: between these two elevations is the fossa of the helix; while at the top of the anti-helix is a small depression, termed the fossa of the anti-helix. Below the opening of the meatus is a deep notch situated between two small prominences; the anterior prominence is the tragus, the posterior one the anti-tragus, and the notch the intertragic fissure.

The auricle or pinna is fastened to the skull by an anterior ligament extending to the zygoma, and a posterior one attached to the mastoid process. There are also two ligaments holding the cartilages of the auricle together; one from the tragus to the helix, the other from the concha to the anti-tragus.

The muscles of the auricle are of two kinds, those which attach it to the head and those extending from one part of the auricle to the other. The former move the auricle backward, upward and forward; the latter are unimportant.

The external auditory meatus, or auditory canal, is an inch and a quarter in length, is directed forwards and inwards, and extends from the concha to the membrane of the tympanum, being formed by cartilage externally, and by bone at its inner extremity. The cartilaginous portion is half an inch, the bony part three-quarters of an inch long. The meatus is lined by thin integument supplied with hairs, and ceruminous glands which secrete the cerumen or ear-wax.

The tympanum, or middle ear, is a cavity lined with mucous membrane, situated within the petrous portion of the temporal bone, communicating with the pharynx by the Eustachian tube, and traversed by a chain of ossicles, or small bones. These connect the membrane of the tympanum with the internal ear, and thus transmit vibrations from the membrane to the structures contained in the innermost portion of the organ of hearing. The tympanum is bounded above by a thin plate of bone separating it from the brain cavity; below it is separated from the jugular fossa by a bony layer; externally its wall is the membrane of the tympanum and the circle of bone to which this is attached, while its internal wall is the partition between the middle and internal ears. The posterior wall shows several apertures, the openings of the mastoid cells; while the anterior wall presents two orifices separated by a lamina of bone. The upper opening is the canal for the tendon of the tensor of the tympanum muscle, the lower is the Eustachian tube leading down into the throat, while the bony septum is named the cochleariform process.

The membrane of the tympanum, forming part of the outer wall, is a semi-transparent oval membrane, placed obliquely, so that it inclines downwards and inwards, and composed of three layers. The outer layer is tegumentary, like the lining of the

meatus; the middle is fibrous and elastic; the internal is mucous and derived from the lining of the tympanum. The handle of the hammer bone, or malleus, is attached to the membrane of the tympanum.

The internal ear or labyrinth is the portion of the organ of hearing to which the fibrils of the auditory nerve are distributed; while the external and middle portions of the ear are simply the conducting apparatus which brings the vibrations of sound to the sensitive nerve filaments spread out upon the surface of the inner ear. The internal ear is divisible into the vestibule, semi-circular canals and cochlea, which are irregular cavities within the substance of the petrous bone. Within these cavities lies a membranous sac, corresponding in shape with the bony vestibule, semi-circular canals and cochlea, named the membranous labyrinth. Between the membranous and bony labyrinth is a serous fluid called perilymph, and within the membranous labyrinth is a similar fluid, the endolymph. The membrane of Corti, which has to do with the appreciation of sound and tones, and the mechanism by which the equilibrium of the human body is maintained in walking, aviation and other capabilities, are of superlative interest in physiology. They rival the astounding creations found in the eye for the production and control of vision, and in the larynx for the production of speech and song.

II. PATHOLOGY AND TREATMENT OF WAR WOUNDS OF THE FACE.

CHAPTER IV

WAR WOUNDS OF THE FACE AND THEIR TREATMENT.

Gunshot wounds received in battle present varying qualities, dependent upon the projectile which causes them. Bullets from a rifle inflict a different injury from that caused by machine gun bullets; shrapnell missiles damage tissues in a way unlike that shown in traumatisms from shells, mortars and grenades. The shape and character of the wound is often modified by the size, shape, velocity and deviation in contour of the missile. The projectile may have obtained from prior contacts and from obstructions through which it has passed a new capacity for harm. More than that, it may while traversing the injured man's tissues cause damage of a wide area of soft tissues by tearing them apart or by imparting such velocity to fragments of bone, clothing or equipment as to create new missiles within the patient's own structures. Devitalization may perhaps be caused by the exceeding velocity of the traveling missile having caused injury to the cells of untouched surrounding tissue. Sabers, swords, bayonets, knives make terrific wounds of an incised character which also are foreign to the injuries seen in civil surgical practice.

Another important item in the study of war surgery is the facilities with which all wounds received become contaminated with bacterial organisms. The battlefield and the trench conduce to contact with the filth of stable, latrine, and fertilized field or garden. The soldier's body is often unwashed for days and perhaps soiled for hours with urine and excrement. The bayonet charge and the sword thrust furnish weapons not very dissimilar to the cleaver and knife of the abattoir. Little wonder that within six or twelve hours after its reception a wound shows the

beginning of an infectious process. The anaërobes, uncovered when a yearly manured field is plowed into hills and hollows by gigantic explosive shells, gain ready access to albuminous fluids and tissue warmth of a wounded soldier. Thus tetanus, gas bacillus gangrene, as well as streptococcus, staphylococcus and pyocyaneus diseases are frequent complicating sequels of battle injuries.

The tissue resistance is greatly lowered, too, in men who have for days been losing sleep, suffered from lack of food and water and sustaining hours of anxiety and fear. Hence soldiers at the front present a fertile soil for bacterial infection to run riot after wounds have been given them.

It will be seen that face wounds, so frequent in trench warfare, require different handling from those to which civil surgeons are accustomed. Clean surgery may seldom be expected. One is carried back to the days of the ante-Listerian surgery of the middle of the nineteenth century. Surgeons accustomed only to civil hospital practice must expect to see unfamiliar wounds of head, neck and face; secondary hemorrhage will be frequent, gangrene common, septicaemia and pyaemic infractions and abscess not rare.

Recollection, however, of the sanitary effect of outdoor life, plain food and sufficiency of exercise will explain the satisfactory healing of promptly treated wounds in those soldiers who have been injured in the camps, cantonments, hospitals away from the firing line. A man in training at a military camp is likely to be in better athletic form than when at home in a city or even a rural habitat. Under such circumstances, the military surgeon has better tissues to furnish resistance to infecting agencies than has the civil surgeon whose patients are of the general type of the over-fed or under-fed city dweller.

Contemplation of these facts proves the necessity of early attention at the front to reconstruction of facial injuries before infection has had a chance to develop from the contaminating agents thrust into the soldier's tissues on land or sea. Contaminating foreign bodies must be promptly removed and a sterile wound created by surgical removal of devitalized tissues and of pockets furnishing foci of bacterial activity. Immobilization also is a valuable adjunct in treatment. If this is impossible

free drainage must be established until suitable reconstructive efforts may be undertaken. The sooner this reconstruction is obtained the better; provided infection has been anticipated and prevented, or at least limited by antiseptic applications and free drainage of every possible retention cavity.

Thiersch shavings were taken from back

Grafts shown on sacrum and buttock

Thiersch shavings taken from thigh

Fig. 36.— Roberts's case of deep burn of sacral region and buttock, showing healing with Thiersch grafts. Grafts taken from thighs and shoulder and covered with gauze veil, sealed at borders with collodion to plevent displacement at early dressings. (*From Keen's Surgery.*)

Sailors wounded on shipboard are probably less liable to infection of their wounds than are soldiers injured in engagements on land.

Contusions of the face are disfiguring from the swelling and discoloration which they cause. The loose subcutaneous tissue of the eyelids especially permits extensive extravasation of blood, after contused wounds in the vicinity of the eyes. The puffy swelling disappears in a day or two, but the cutaneous discoloration lasts for a week or ten days. The skin over the extravasated blood is at first bluish-black, but gradually becomes greenish and then yellowish, before assuming its normal hue.

Fig. 37.— Stump covered with whole-thickness grafts, which are held in place by the rubber impregnated meshed material, secured by adhesive straps. (*From Keen after John Staige Davis.*)

A similar discoloration of the forehead may be seen when a wound of the scalp has been received, because the extravasated blood gravitates downward into the tissues of the upper part of the face. Sub-conjunctival ecchymosis, giving a red discoloration to the white sclerotic region of the eye, occurs in blows received upon the eyeball, in rupture of conjunctival vessels from coughing, vomiting, or straining of stool, and in fractures of the orbital plate of the frontal bone or of the other bones which take part in the construction of the orbital cavity.

Pressure and cold compresses, employed for a few hours after a contusion has been received, tend to arrest the subcutaneous bleeding and thereby diminish the consecutive tumefaction and discoloration. Pressure probably does little good after a couple of hours. The cold applications should be discontinued at the end of eight or ten hours; they are likely to interfere with the process of absorption, upon the activity of which the removal of the blood and inflammatory desposits depends.

In cases characterized by great ecchymosis numerous minute punctures of the skin may be made, through which the blood is to be squeezed out of the tissues. Perfect asepsis must be maintained, if this means is adopted, in order to avoid the occurrence of suppuration and conspicuous scarring. Solutions of ammonium chloride (gr. v-x ad ℥ j), tincture of arnica and similar lotions, used to hasten the absorption of the blood and the return of the skin to its natural color, probably owe their reputation largely to the friction employed in their use. Rubbing with adeps lanae or other ointment is probably beneficial in promoting absorption. Agnew believed that surgical shock greatly delayed removal of extravasated blood, and advocated, in addition to warm and stimulating applications, tonics and ample diet to hasten absorption. Pugilists at times paint the skin with flesh-colored cosmetics to conceal the black and blue marks due to bruises.

Incised and lacerated wounds must be rendered aseptic by thorough cleansing with soap and water, followed by the application of mild antiseptic solutions. Anesthesia will often be required to enable the surgeon to do his full duty in this respect. Recent studies of wounds received in war prove that prompt healing will often be obtained by a very careful removal of foreign bodies and a free, very free, excision of lacerated and bruised structures followed by cleansing with sterile salt solution and suture. Cavities must be drained by gravity. The continuous soaking of the deep tissues with antiseptic solutions, such as sodium hypochlorite of Dakin, or the thorough local application of di-chloramin T, in eucalyptol oil or chlorcozane(?), will render infected structures soon suitable for closing with stitches. Care must be taken to keep strong antiseptic solutions out of the eyes, nose, and mouth.

The free blood supply of the face enables its structures to sustain much damage without the induction of gangrene. Heat applied by means of affusions of hot sterilized salt solution or hot antiseptic washes will aid in revivifying damaged skin. The temperature of the lotions should be about 105° F. Dry heat may also be used by means of a small rubber bag containing hot water. It may be wiser to excise large areas of tissue than to permit suppuration or other forms of infection to occur in the depths of wounds. This is especially true in war wounds, which are so often contaminated with bacteria of streptococcus and staphylococcus disease, and the bacilli of tetanus, gas gangrene, and of pyocyaneous infection.

The approximation of a wound should be made by sutures employed in accordance with general surgical principles. When sterilization and neat coaptation are evidently impossible, because of the character of the wounds or their multiplicity, very frequent irrigation of the surface of the face will wash away discharge and prevent septic accumulations. The lotion should be used about every two hours. Very free drainage by tubes or large openings become necessary in wounds involving the mouth and jaws, when gunshot lacerations or deep perforations are present. Then it may be necessary to use only a few sutures.

When actual loss of skin has occurred and the gap cannot be covered by sliding or transferring flaps, immediate skin grafting by shavings cut from the thigh or arm may be adopted. It is necessary for success that the raw surface be thoroughly sterilized and bathed with hot and sterile normal salt solution. The skin shavings cut from the thigh with a razor are laid while warm over the denuded surface in such a manner that their edges overlap. Krause graft consisting of the entire thickness of the skin may be successfully used, if perfect asepsis is obtained, and the air pressed out between the raw surface and the graft. The graft should have the subcutaneous adipose tissue removed from its inner surface.

The edges of wounds of the nasal, auricular or tarsal cartilages should be brought together by fine sutures, which may be carried through the cartilages if necessary. Often the skin over the cartilage will give sufficient hold for the stitch.

Local emphysema of the cellular tissue of the face may occur,

when the lachrymal sac is ruptured, or the frontal or mixillary sinus or the ethmoid cells opened by fracture. When the air escapes into the loose tissue of the orbit, protrusion of the eyeball and crepitation, felt on palpation of the ocular region, occur. The deformity from the swelling due to air in the connective

FIG. 38 — Deformity due to delay in replacing structures after shell fracture of mandible and laceration of chin and neck. Case from early months of war. *(Seen later by Dr. Thomas G. Aller, Jr.)*

tissue needs no treatment. Subcutaneous rupture of the duct of the parotid gland has been caused by blows on the cheek. The saliva may then burrow into the tissues of the face and neck, causing an emphysematous swelling and much deformity. Pressure will probably be the only treatment required in such injuries.

Gunshot wounds often induce great facial deformity because considerable areas of tissue are carried away by the missile. Much permanent disfigurement may result from displacement of the bones, actual loss of tissue, or secondary circatricial contraction in these and other injuries. Powder grains imbeded in the

FIG. 39.—Wounds from powder, dirt and small pieces of stone, which must be removed to avoid tattooing. Palsy of lower fibres of facial nerve without external wound. (*Courtesy of Dr. H. W. Scarlett.*)

skin should be picked out, otherwise the carbon in powder will leave bluish tattoo marks. The distortion due to bony lesions must be prevented, as far as possible, by early and accurate replacement of fragments. A great amount of power may be required to pry up depressed fragments or alter the relation of bones driven together by the vulnerating force.

The side of the face is greatly deformed by depressed fracture of the zygomatic arch. The depressed portion should be elevated with a lever, introduced through an incision made parallel to the margin of the zygoma. A similar elevation of bone may be required when the anterior wall of the sinus of the upper jaw

FIG. 40.— War wound of cheek.
(*Courtesy of Dr. H. W. Scarlett.*)

has been crushed in. Hooks like icetongs have been used to lift up the fractured portion.

In extensive osseous injuries, the bones should be accurately adjusted and held in position, if necessary by chromicized catgut sutures, introduced through drill holes. Sterilized bone or ivory pegs or steel nails and tacks may be employed to nail the bony

structures together, if sutures are not effective. The nails may be removed later or allowed to become encysted; bone or ivory pegs will be absorbed, if the wound remains aseptic. Teeth knocked out should be washed with mild antiseptic solution and replaced in the socket previously sterilized. The adjoining teeth may be utilized as a sort of splint to which the loose teeth may be tied or wired. Keeping the mouth bandaged shut, as in fracture of the mandible, or the use of an interdental splint will aid in maintaining immobility until the replanted tooth becomes firm in its bed. This requires a week or two.

Fractures of the mandible may be held in place by holding the broken bone after reduction against the upper jaw by wiring the upper bicuspids in proper occlusion with the lower bicuspids. In war surgery such wiring must not be allowed to remain, if the patient is liable to become sea sick during transportation overseas.

Shrapnel bullets having low velocity seldom ricochet with sufficient force to produce penetrating wounds. Experience in the Spanish War showed that probing bullet wounds was undesirable, and x-ray localization better; occlusive dressing is better for Mauser and shrapnel bullets unless there is a great probability of special cause for infection. Even ricocheted bullets and those passing through other objects do not always cause infected bullet wounds, as frequently as previously believed. This is so, apparently in slow velocity as well as jacketed bullets. Do not use ordinary probe or Nélaton porcelain top probe. These statements apply to penetrating as well as to perforating bullet wounds. Non-interference is of great importance in such wounds in civilian practice; but less so in present war practice. Allow defensive processes to be set up in usual gunshot wounds in civilian work; later if necessary one can localize and remove them.

Bullet wounds of the face should seldom be probed. Little information is gained with the probe that cannot be obtained without it with the x-ray plate or fluoroscope. Such wounds may be sterile unless they open one of the cavities of the face. The surgeon's object should be to obtain prompt union by organization of the moist sterile blood-clot within the bullet track. Exploration with the probe is likely to interfere with this method of healing. Extraction of the ball through the opening of en-

trance is very unlikely to be possible. Many bullets buried in the face need not be found. Unless the situation of the buried missile is apparent, it is better surgery to gain primary antiseptic occlusion of the wound with a gauze pad or a gauze and collodion dressing. A minimum deformity from scar is obtained if union without suppuration occurs. Any redness, swelling, or pain pointing to sepsis should be met by immediate opening of the wound. It should then be syringed out thoroughly with an aseptic solution such as di-chloramine T and oil of eucalyptol and dressed in a manner to favor drainage of fluids. Extraction of bullet or other infected object carried inward may then be extracted. The possibility of poisoning by antiseptic solutions entering the mouth or œsophagus during such syringing should not be forgotten. The fluoroscope or study of x-ray plates may so locate the missile as to render extraction wise or imperative.

Punctured wounds should be managed by similar occlusive dressings, if made with clean and smooth instruments probably sterile. If the vulnerating instrument was manifestly septic or if the wound at a later time shows signs of infection, the tissues should be widely opened and sterilized, as in those parts of the body where scarring is not objectionable. A properly planned incision will cause less disfigurement than the cicatricial distortion consequent upon a neglected septic wound. Septic material may contaminate the wound, because the skin was greatly soiled, the clothing perforated, or because the missile had ricocheted after striking the ground.

War wounds of the face are often of much more serious nature than mere bullet injuries. The control of hemorrhage is of first importance in such wounds; next comes the relief of surgical shock. Then the removal of foreign bodies, and the elimination of contaminating contacts should be undertaken. Every reasonable effort should be made to clean the injured tissues and remove from them the imbedded missiles, or portions of clothing, wood, wire, stones, or mud. The aid of Roentgen rays should be obtained to locate pieces of metal buried in the depths of the face. The cleansing procedure should be thorough and, when practicable, it should be carried out early. By early is meant before the stage of contamination has had time to become the stage of infection. This is probably within the three or six hours imme-

diately following the traumatic insult to the tissues. Devitalized soft tissues should be almost ruthlessly cut away with aseptic instruments and hands. Structures suspected of being likely to furnish pabulum for micro-organisms should be excised to a degree less, perhaps, than that demanded in wounds of the trunk or

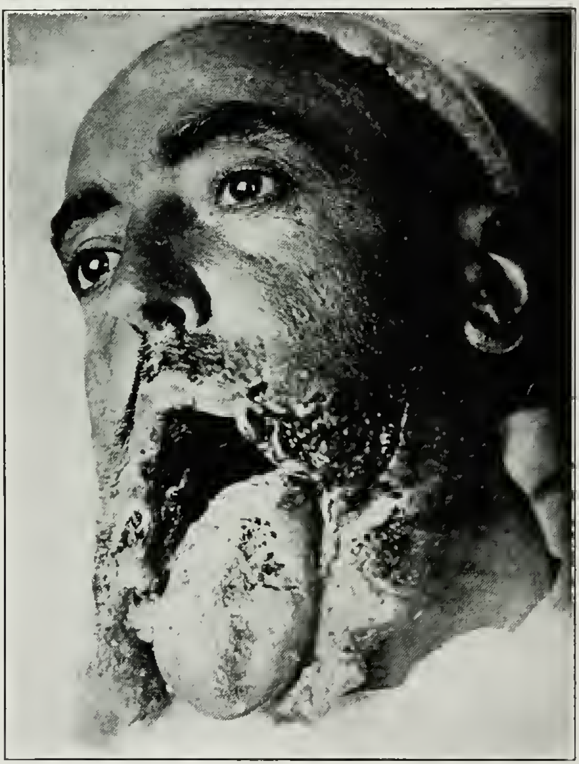


Fig. 41.—War wound of mouth and chin, with portion of mandible carried away.
(*Courtesy of Dr. H. W. Scarlett.*)

limbs; but much more extensively than is usual in the facial injuries of civil life. The endeavor is to obtain an aseptic or a relatively aseptic surface for immediateate suturing.

The theory at the bottom of this method of dealing with open wounds is prevention of septic dangers and the prolonged convalescence incident to the admission of pyogenic and other organ-

isms. Should these find culture media in bruised, lacerated, and fluid-logged structures they will multiply and produce their specific biologic poisons, causing gas gangrene, tetanus or suppuration. Their eradication assumes the character of an operation for malignant disease. Fragments of bone and cartilage need not be subjected to quite such radical expulsion as are the soft tissues of suspicious appearance. This exception applies to fractures of the bones of the face; but is scarcely applicable to infection of bones of the extremities.

Reconstruction of the skeleton outlines, and careful coaptation of bony fragments with their immobilization should next claim the military surgeon's attention. Fragments of comminuted fractures should not be removed too hastily. They often live and may aid in reconstructive attempts upon the maxillary or mandibular arches.

Closure of the soft tissues follows or is synchronously effected with the reposition of the bony structures. Early closing of face wounds hastens healing and prevents secondary infections. Hence a sterile condition is to be obtained promptly. So soon as the surgeon believes that he has before him a non-contaminated or a successfully cleansed wound, he should apply sutures. If he is doubtful of that fact, let him apply a mild antiseptic wash and draw together the parts with a few stitches not too close together. If he believes the wound to be infected, let him apply to every raw surface and pocket di-chloramine T in oil, or paint the parts with tincture of iodine or some other antiseptic liquid and leave the parts in a condition to drain away fluids through the action of gravity.

It will be seen by this description of treatment that the same general principles apply as are conducive to rapid healing in open injuries of other regions. Large wounds of the head, face and neck may be managed, therefore, by the adoption of instillation with neutral solution of sodium hypophosphite after the method of Carrel; or di-chloramin T may be employed according to the technic of Lee and Furness of Philadelphia.

The Carrel method may be epitomized as follows:

(A) Aseptic cleansing of wound accomplished by (1) mechanical removal of foreign bodies, (2) painting the vicinity of the wound with tincture of iodine to create a sterile external opera-

tive field, (3) trimming away bruised skin edges with a sharp knife. (B) Searching for infecting material in all the ramifications and pockets of the wound. (C) Excising the track of the projectile, in the tissues, soft and bony, and all suspiciously damaged structures that are likely to have been so lowered in vitality by bruising, tearing or delay in removal of contaminating particles as to supply micro-organisms a fertile soil. (D) Obtaining

Fig. 42.—Multiple wounds of eyes, nose, cheeks and chin from fragments of projectile. Forehead was protected with helmet.
(Courtesy of Dr. H. W. Scarlett.)

absolute hemostasis. (E) Immediate approximation with sutures without drainage.

If there is doubt about the perfection of this sterilization of the wound, which may be determined by taking cultural tests, the instillation of the neutral sodium hypophosphite solution or the application of some other antiseptic may be carried out until

a sterile wound is obtained. Then the wound is closed. No counter openings for drainage are established in the Carrel method, as a rule, because the intention is to keep pockets full of the disinfecting solution, in order that it may come in contact with every raw surface and remain in contact several hours to destroy the vitality of the infecting organisms. The Dakin solution loses its germicidal property rapidly. Therefore the method is troublesome, as it requires constant instillation through small tubes in the wounds. Di-chloramine T in eucalyptol oil 5 per cent., or in chlorcosane of the same strength, can be employed more conveniently because the chemical in oily menstruem or in chlorcosane retains its antiseptic efficiency for 24 hours. A single application a day is therefore sufficient. It and similarly applied agents are therefore generally preferable in surgery of the face. Instillation of Carrel-Dakin solution for superficial wounds is obtained by using a thin layer of gauze and allowing the solution to flow on top constantly. Lee and Furness place a very light dressing of two or three layers of gauze over the wound, which has been sprayed with the di-chloramine T solution. In face wounds, which have been made sterile and closed, I prefer a single layer of gauze or even no dressing over the surface.

Tetanus antitoxine in prophylactic doses should be given to all wounded men at the war front, when the wounds are evidently such as have come in contact with mud or with articles likely to have been infected with dirty clothing or manured soil.

Early replacement of the displaced soft parts is important, because cicatrization of unsutured wounds gives rise to very great contraction of the fibrous tissue formed from granulations.

Thus far the general surgeon has had full sway in the management of patients with serious war wounds of the face. The principles upon which treatment has been conducted are those applicable to surgery of other regions of the human body. A dental surgeon, or a specialist in the use of instruments and methods used in oral surgery, is generally necessary for obtaining the prompt and proper adjustment of fractures involving the upper and lower dental arches. The surgeon will do well in many injuries to have the advice and cooperation of such an expert. It is much easier to prevent facial deformities by the immediate

reproduction of at least a semblance of anatomical correctness of outline than to delay correction until after cicatrization with distortion. Contractions and distortions by fibrous tissue filling in openings and dragging soft parts, and even bone, into unphys-

Fig. 43.—A pedunculated flap. Skin-grafting and flap from back tacked to cranium. The tacks had been removed, because of adhesion of flap, before photograph was taken. Scalp torn off by machinery some six months previously.
(*From Keen's Surgery, from Roberts.*)

iological conditions and shapes will demand great labor for successful reconstructive surgery. Immobilization of jaws may require great technical knowledge and manual skill in the construction of efficient interdental or intermaxillary splinting appliances. Few general surgeons have had sufficient training in this branch of oral surgery and prosthesis to give the best chance to the patient.

When great masses of skin, muscle and even bone have been torn away from the face by shell wounds or cut away by sword cuts, there occasionally remains a hinge-like attachment to the head or face. This form of injury will sometimes permit replacement of the tissues in a fairly normal situation; but there is no

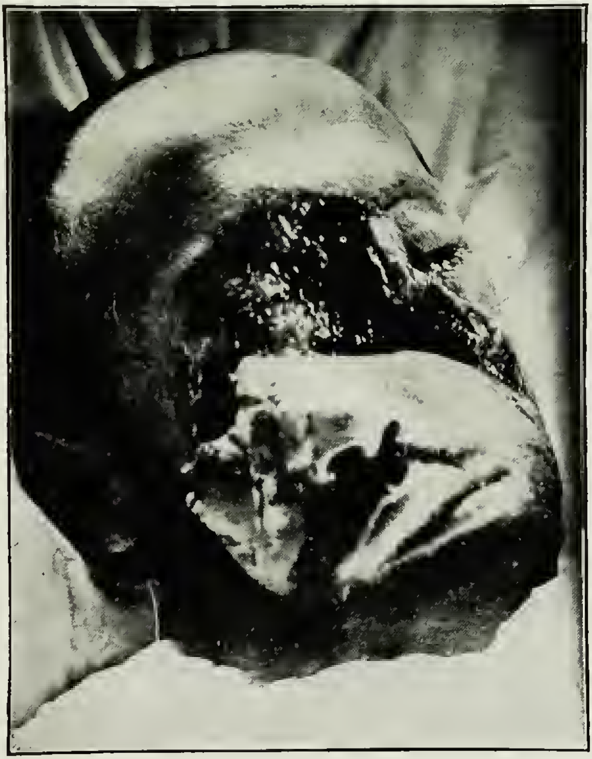


FIG. 44.—Nose and cheeks with part of maxillae torn from facial bones and displaced downwards by shell wound. (*Dr. H. W. Scarlett.*)

satisfactory way to suture the drooping tissues in position. It may be possible, however, to attach a band of metal to the head and from this to carry a spring with a pad to press the loosened tissue against the region to which it should be sutured. Tacks may be used to nail such a flap in position if there be firm bone underlying it.

It is better to move a wounded patient to a place where he can be kept and nursed for a few days after serious operation than to operate and immediately afterwards remove him to the place where he is to spend the first critical period of his illness. Therefore the casualty clearing station is now the usual place for dangerously wounded men to be subjected to operation rather than the field ambulance or advanced dressing station. This, according to Bowlby, is the custom in the British army.

Hey's table shows that at one of the forward casualty clearing stations 38 fractures of the jaws were operated upon out of 1,403 fracture patients received during the heavy fighting of one battle. During the same period there were 277 ligations of arteries, 247 operations for joint injuries, 431 amputations, 17 tracheotomies, 33 plastic operations, 43 enucleations of eyes, 2,056 other operations for gunshot injuries.

TREATMENT OF WOUNDS.

Duval says that wounds of soft parts should be treated within 12 hours, the incubation period of infection after simple contamination, by thorough exposure, excision of damaged structures and removal of foreign bodies. This leaves a surgical wound similar to that due to an operation, though not so free from the possibility of infectious organisms as an aseptic operation on aseptic tissues. The war wound thus prepared may be subjected to immediate or "primary" suture or treated by progressive sterilization until secondary suturing seems probably safe. The time of closing with secondary suturing may be determined by bacteriological examination of the excretions from the wound, when such daily laboratory investigation is practicable.

Primary closure requires a surgeon of experience, good equipment, immobilization of wound, and a stay in the hospital of about ten days or two weeks under the care of the original operator. This may be impossible during strenuous war activity, when many casualities are being received from the front and quick removal from the casualty stations is required. Under such emergencies it is wise not to employ primary sutures early in the treatment; but to delay closure, and to employ for a time antiseptic dressings after cleansing, excision of damaged parts, and removal of imbedded foreign materials.

Haycraft has, it seems to me, well stated the requirements of good surgery in general. His words apply equally well to wounds of the face and neck, and corroborate Duval's experience. Primary suture has the obvious advantages of easy, rapid, and painless dressings, and promotes economy of time and materials after the patient leaves the operating room. A disadvantage, however, arises if the stitched up patient is evacuated within the first week or ten days after the primary suture. Motion then "may just turn the balance during the early days of local reaction, when the tissues are getting the upper hand," and result in septic developments. Unless the original operating surgeon is at hand to decide whether the wound should be reopened, the golden opportunity to open, disinfect and drain may pass and the patient's chances of life and cure be forfeited.

When primary suture is not done, dressings of 2.5 per cent. of soft green soap may be used for disinfection, and for dressings and packs, according to Haycraft. Di-chloramine T, flavine, tincture of iodine, 14 per cent. sea-salt solution, or other antiseptic agent, may be applied to the unsutured wounds. Wright's hypertonic solution or the Dakin-Carrel hypochlorite instillation method may be employed later. Flavine is probably satisfactory as a primary dressing in such cases, but is seemingly deleterious in later stages of wound repair.

The soap solution recommended by Haycraft appeals to me. He makes it by using pure, hard soap, 1 part dissolved in hot water sterilized by heat 20 parts. This solution is to be diluted with an equal volume of sterile water when applied to the wound for cleansing or as a primary dressing.

A "retarded primary" suturing can then be made within a week. The early excision should be complete whenever anatomically practical. It is wiser to take the surgeon to the wounded men than to transport the wounded soldiers to the surgeon. The surgeon should take the needed time to do the excision in a thorough and careful manner and not be satisfied with hasty work. These are the canons of successful surgery in civilian as well as military practice.

Lagout is right in his stand that an incomplete operation of urgency is dangerous to the patient. He declaims against a suggested compliment in operating tables "accommodating 50 to

100 wounded in 24 hours," and affirms that this purely quantitative efficiency has no value and is often a cause of bad management from the beginning. The results are apt to be indefinite suppuration, deep retracted scars, muscular scleroses, incurable atrophies, and deplorable function of tissues.

Irrigation as usually adopted does not reach the micro-organisms below the surface of the wound. Those on the surface have already been extended from the tissues by the plus pressure in the blood and lymph vessels in relation to the surface of the wound.

The antiseptic solutions used for irrigation may be absorbed by the superficial vessels, but probably fail to reach the intervascular spaces; therefore some writers contend that little is gained by the irrigation with antiseptic solutions. Hot wet dressings may be useful in relieving pain and aiding drainage by preventing crust formation by drying of secretion. After all, in this view, it is leucocytic action and the antiseptic quality of the blood serum which are of value in the healing process. Wright's theory of washing out the wound by increasing serous transudate is founded on some such basis.

Di-chloramine T (toluene-sodium sulpho-chloramide) has no action on albumin, is almost free from toxicity, and is of special value, it is believed, in sterilizing wounds of the mouth. It may be used as an atomizing spray or applied with small swabs to wounds and infected cavities. It can be employed also as a dichloramine T gauze dressing, according to statements in the "British Medical Journal."

Acriflavine, according to Browning, is effective in dilutions harmless to the tissues, and does not impair the phagocytic powers of the leucocytes. Lorrain-Smith has found effective combinations of bleaching powder and calcium borate in septic wounds. He and his colleagues have published formulas for a solution and a powder which are termed for convenience "eusol" and "eupad." These have given success in rendering foul wounds aseptic. There is some evidence that flavine is valuable as a primary dressing, but deleterious in the later stages of wound healing.

In Philadelphia a new product with a long chemical name, called for convenience "mercuro-phen," also has seemed to be

of great germicidal value. It is prepared by chemical manipulation of mercury and phenol. The salt pack and Morison's bismuth subnitrate, iodoform and paraffin mixtures have been used in suppurating wounds with apparent advantage. The Carrel-Dakin solution and method and the di-chloramine T solution seem to have displaced the other antiseptic agents. It should be recognized that prompt incision of damaged tissues so far as anatomically wise is of great importance in general surgery of the war. It is to be exercised with greater restriction, however, in face wounds.

Mouth wounds are so liable to be accompanied by fractures of the mandible with the teeth and fragments of bone acting as secondary projectiles that large lacerated wounds are common in this region. Infection and secondary hemorrhage render such gunshot injuries of serious import. Irrigation and drainage, after such substitutional reconstruction of the bones as is possible immediately after injury, are the obvious indications for treatment.

The flexibility of the lips and their attachment to the bone only in the middle line make plastic transfer easy. The adjacent integument and subcutaneous fat and the muscles of the neck furnish material for reconstruction of the orifice of the mouth. Here, as in reparative surgery of the eyelids, nose and ear, reconstructive operations are to be carried out by transfer, interpolation, and transplantation, or by transportation with the hand or arm. These plastic methods often accomplish unexpectedly satisfactory results. Repeated operations are essential in the more complicated procedures. A crude resemblance of the normal organ is first constructed. Subsequent modifications may then be made by succeeding operations modelling the organ into a more seemly contour. Many months are frequently required for the surgeon to reach his goal.

CHAPTER V.

ASSOCIATED INJURIES IN WOUNDS OF THE FACE.

WAR INJURIES OF LARYNX, TRACHEA, AND ESOPHAGUS.

Gunshot injuries of the upper air passages and esophagus occur as complications of wounds of the jaw and other parts of the face. Hemorrhage into the larynx, trachea, or esophagus, and submucous bleeding or exudation causing swelling, lodgment of foreign bodies, fractures of cartilages, contusion or section of nerves may occur from direct injury. Portions of the laryngeal structures and tissues of the trachea or esophagus may be carried away by the missile. Edematous inflammation in the larynx may lead to asphyxia, a fatal result of complicated wounds in this region. A moderate amount of bleeding into the larynx may kill in a similar manner. The general surgeon must be prepared in such emergencies to perform immediate laryngotomy or tracheotomy before dyspnnea is too urgent. Occasionally intubation of the larynx may be sufficient, but if the patient is to be transported or be taken from surgical observation, laryngo-tracheotomy or tracheotomy will be safer.

A hasty opening of the air passages may be done in the crico-thyroid space with a penknife or with an ordinary trocar and canula. When a tracheotomy tube is not at hand for insertion, a narrow strip of the rings of the trachea may be excised, and the long gap in the trachea kept open by suturing the edges of the opening in the windpipe to the skin of the neck. In whatever way the larynx or trachea is opened, the external opening of tube or wound should be covered with one or two layers of gauze to prevent the inspiration of dust or insects. The air breathed should be kept warm and moist, when circumstances permit. Under such efficient preventive and restorative handling dyspnoea, relief of threatening symptoms may be obtained. Fractures of cartilages, whether open from penetrating or perforating bullet wounds, or closed fractures from contusions, may cause a similar difficulty of breathing from swelling or bleeding.

The secondary results of these injuries to the air ways or food passages may be deformity from scar contraction causing inter-

ference with speech, breathing, or swallowing. The injuries are often so complex that a high degree of surgical acumen is essential for successful outcome. A complete cure may sometimes be effected even in mutilating injuries such as translaryngeal perforations and impaction of metal fragments.

Nerve injuries may cause aphonia from paresis or complete paralysis, giving partial or complete loss of mobility of the vocal chords. Localization of the lesion may perhaps be better determined by special laryngological skill than by x-ray methods. A similar specialized ability may be needed for the successful removal of foreign bodies in the larynx, trachea, and esophagus.

CRANIAL COMPLICATIONS OF INJURIES OF THE FACE.

War wounds of the face may be complicated with fracture of the anterior part of the cranium in the vicinity of the eye and nose. Fracture of the midregion of the cranial base also may occur in connection with force conveyed to the temporal bone through the condyle of the mandible at the temporo-mandibular articulation. Aural traumitisms from direct blows upon the ear may result in severe intracranial lesions. The specialist in facial surgery should, therefore, be on the alert to recognize symptoms of such damages to the bones and intracranial structures as may imperil the patient's life or modify the treatment of the more apparent lesions of the facial tissues themselves.

The frontal bone in its horizontal portion may be split, causing hemorrhage within the orbit. Fissures may occur through the superior portion of the orbital ridge. Subjunctivial extravasation of blood and unusual prominence of the eyeball point to possible osseous lesions of this bone. The proptosis or extrusion of the globe may be very slight and gradually increase. If the bleeding within the eye socket is slow, the evidences of blood between the sclerotic coat and conjunctiva may not develop for several hours or days. Paralysis of the ocular muscles, inducing strabismus of varying forms and interfering with the reactions of the iris are usually due to deep cerebral lacerations and must not be allowed to escape diagnostic attention.

Nasal traumatisms may be complicated with fracture through the frontal bone; and also cause breaks in the ethmoid bone, where it forms part of the anterior fossa of the cranium. Palsy

of the olfactory nerve may result, and intracranial pressure from meningeal or cerebral bleeding within the brain case give rise to mental and physical manifestations. The surgeon should bear in mind that tardy advent of cerebral symptoms or their gradual increase within the first twenty-four hours soon after injury of nasal, ocular or aural regions means continuously slow leaking of blood. Operative attack upon the lacerated vessel then is strongly indicated.

Incision of the skin and subjacent tissues to inspect the surface

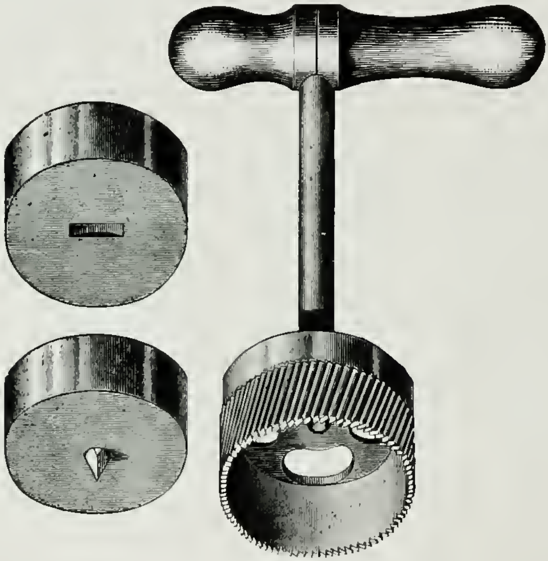


Fig. 45.— Roberts's aseptic trephine. It has a thin sawing crown, and a drum-shaped centering cylinder instead of a hollow stem and center pin.

of the bone in the locality beneath the wound, early neurological study of localizing symptoms, and exposure of the brain by bone operation in accordance with topographical indications are eminently the duty of the surgeon. The ophthalmoscope will often afford valuable evidence, as will inspection of the tympanic membranes, the nasal cavities and the posterior wall of the pharynx.

The difficulty of obtaining an accurate history in wounds during war makes it wise to refrain from dismissing injuries of the head as trivial unless careful examination has been carried out.

The first aid treatment by the soldier himself may or may not be efficient. When the scalp has been opened to examine the bone, slight differences in appearance give good reason for opening the bone to examine the contents beneath the point of impact of a projectile. A rule of rather wide application is that given by the author many years ago: Open the scalp to examine the bone; open the bone to examine the brain in suspicious cases, rather than have a fatality occur from unrecognized, and, therefore, untreated brain injury.

Projectiles of low velocity, such as shell fragments and shrap-

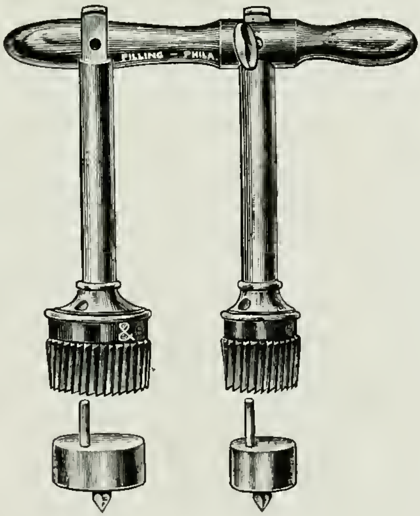


FIG. 46.— Roberts's aseptic trephine, later model.

nel bullets, by glancing blows may cause fracture of the skull with little external damage. Roentgenological examination will often disclose fissured fractures in the bones of the head that otherwise would never be discovered until the symptoms or autopsy revealed their existence. Many cases, therefore, of possible brain injury should be kept under observation with treatment directed to obtaining lessened cerebral activity or irritability.

Erosions or gutter wounds of the skull from rifle bullets and other rapidly moving projectiles may cause marked fracture of

the internal plate of the cranial bones without that condition being revealed by surface evidence. Cranial osteomylitis, subcranial or subdural abscess must be borne in mind as a possible sequel. Wounds upon the dome of the head, therefore, though superficial, deserve careful treatment; they should be managed by excision of damaged tissue, and the application of iodine or other antiseptics in a manner similar to treatment of wounds of the soft parts of the face.

The treatment of depressed fractures, penetrating and perforating wounds of the cranium and brain involve the principles of

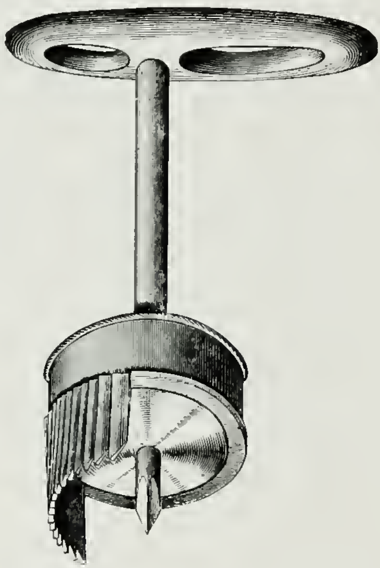


Fig. 47.—Roberts's aseptic segment trephine for making osteoplastic resection of cranium.

surgical treatment of more general character than that which comes within the province of this treatise. The same remark applies to the removal of bullets and other projectiles from the brain cavity.

The cranium may be opened by trephine, wire saw, electric saw or cranial perforator according to the preference of the operator. Once entrance has been obtained, the opening may be

extended by gnawing forceps or other means. Plastic resection of a bony trap door with a musculo-cutaneous hinge permits replacement and early restoration of the osseous covering of the brain after the bleeding artery or vein has been ligated or efficiently controlled by pressure. A comparatively large opening should be made, if a subtemporal decompression is contemplated to remove compressing clots. A wider opening may be required to thoroughly examine the convolutions in cases of more indefinite intracranial lesion.

A very common spot for a subcranial extravasation of blood from a fracture is near the anterior inferior angle of the parietal bone. Here the branches of the middle meningeal artery occupy grooves in the bone. The groove occasionally exists in part as a tubular canal. Frequently the artery is torn, sometimes probably without actual fracture in this region because of this relation to the bone. Here also the thickness of the cranial wall is less than in most other regions.

It is possible to gain access to the brain and its membranes without elaborate instruments. If necessity arise, this can be done by an ordinary saw or chisel. The ancient Peruvians are

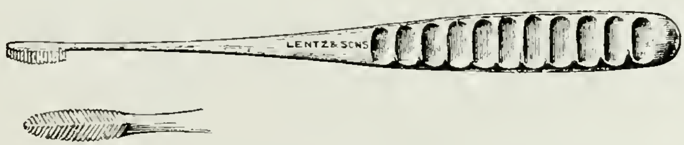


FIG. 48.—Fetterolf bone rasp, for making groove in cranium at base of osteoplastic trap door.

known to have perforated many brain cases with rude instruments. The tools of a carpenter or a broken blade of a knife might be used to scrape an initial opening in cases of emergency in war surgery. The bones of the dome of the cranium are quite soft in the average individual after the external table has been scraped away. In emergencies of war it would be not very difficult for a resourceful operator to save life by unusual means of entering the cavity of the head.

The trunk of the middle meningeal artery may be uncovered by opening the cranium with a trephine or by turning down an osteoplastic flap of integument and bone. The usual vessel to

be injured is the anterior branch of the main artery. This artery maye be uncovered at a point about an inch and a half behind the zygomatic process (external angular process) of the frontal bone and about an inch and a half above the zygoma. The posterior branch lies about one inch and a half above the external auditory meatus. The trunk itself, just after it enters the cranium, may be found about one finger's breadth above the middle point of the zygoma. The surgeon occupied with acci-

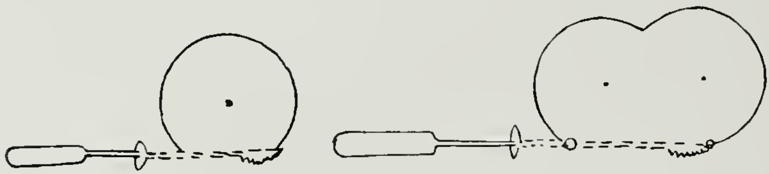


Fig. 49.—Diagram of method of making small and large trap doors with segment trephine and Fetterolf rasp. (*Archives internationales de chirurgie,* 1907.)

dental injuries of the face may be driven by accidents in industrial communities or by wounds in warfare to deal with a slowly arising coma caused by extra-dural hemorrhage in this region. The operation for subtemporal decompression is performed in the same region; but the cranial opening should be placed a little further back than that to reach the anterior branch of the middle meningeal trunk. For decompression purposes Cushing

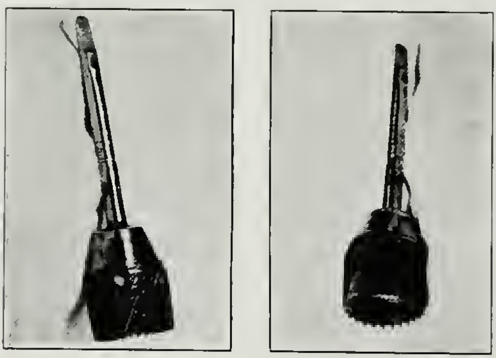


Fig. 50.—Roberts's cranial trephine, devised in 1882, for use with Bonwill surgical engine. Now used with electric motor for making perforations for Gigli wire saw or Masland electric motor saw. The opening in one side of crown is to permit button of bone to be pushed out of the trephine cylinder readily.

prefers to split the temporal muscle and draw the two muscular masses apart rather than to turn down a muscle-flap.

Any form of cylindrical trephine, a combination of trephine and electric saw, the Gigli wire saw or the segment trephine with Fetterolf's rasp, may be used for the craniectomy.

The brain is notably tolerant of contusions and infections; hence an operative delay of two or three days is often permissible, says Cushing. This gives the brain time for preparation to withstand operative attack.

Fig. 51.—The Masland electric surgical saw, when used for cranictomy, is provided with a dural separator introduced through small perforations of the skull. This is discarded when the saw is employed for excision of the mandible and other operations. (*Cadaver operation on mandible.*)

A contralateral decompression may be valuable. After craniectomy one may use a pericranial bridge flap to cover the brain when one fears infection from the original scalp wound. An independent incision through scalp, thus avoiding the wound opening, is valuable if the wound is likely to be infected. Do not operate on brain too promptly. To let bullets remain until case can be x-rayed and carefully studied is often a good rule.

The surgeon may stop intracranial bleeding with muscle

graft as plug, or pressure may be made with gauze. Local anaesthesia with novocain 1 per cent. and adrenaline standard solution 15 drops to 30 cc. of novocain solution may be used.

If patient is asked to cough, he may drive clots and débris of wounded brain out of the cranial opening, thus cleansing the depths of the wound.

In complicated wounds of face with evidence of cerebral compression, it may become necessary to remove enough bone in the subtemporal region, on one or both sides, to allow the brain to expand through the opening in the base of the brain case.

Fig. 52.—Cutting osteoplastic flap of cranium of cadaver with Roberts's trephine driven with electric motor and sawing with Masland electric saw. Small trephine holes are made to admit the dural separator or guard of the saw.

This is especially important in basal fractures with no localizing symptoms sufficient to permit a diagnosis of the exact locality of the intracranial lesion or hemorrhage causing pressure. Keens speaks of a decompressing operation on the opposite side. This may be valuable when it seems not to be feasible on the injured side. The decompression might be made in the parietal region with advantage in some cases. The later experiences in the war zone have seemed to prove that brain wounds from

penerating projectiles do better if the patient is not operated upon at once. Delay for a few days to give time for establishing an increased tolerance of operative risk and to secure proper nursing and surgical care for several weeks increases chance of successful treatment.

The appearance of paralytic strabismus or other evidences of central or peripheral brain disturbance occurring during the con-

FIG. 52a.— Osteoplastic flap of cranium made with electric trephine and saw, turned down, exposing seat of hemorrhage in injury of middle meningeal artery. See cut on page 92. (*Cadaver operation.*)

valescence of wounds of the face should suggest cerebral abscess. This may occur through a fissure in a bone or from septic embolism. The causative septic processes may be in the wounds of the face. Septic processes are particularly liable to be present when sinuses in the frontal, maxilla and other bones have become filled with blood clot or wound secretions. Great attention should, therefore, be paid to the drainage of these cavities, as well as of adventitious pockets occurring in the soft parts. Irrigations with sterile salt solution or other mild antiseptics through appropriate openings in the bone may, therefore, become life-saving measures.

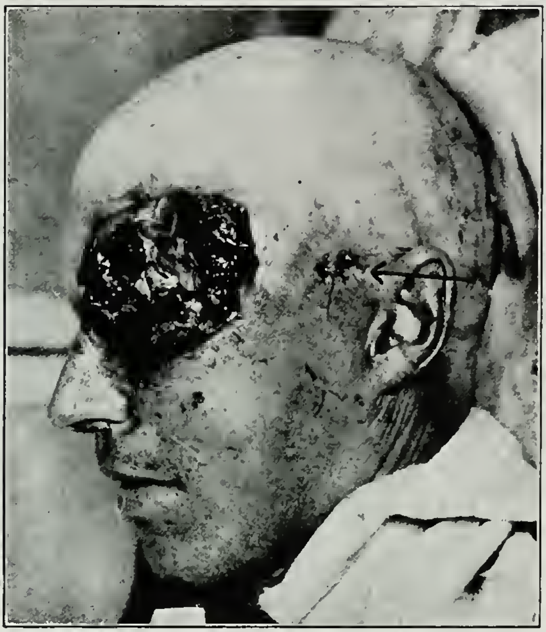


Fig. 53.—Penetrating wound of orbito-frontal region, showing wounds of entrance and exit before operation. Large cerebral hernia. At autopsy two missiles found, one in left temporal lobe, other in right occipital lobe. (*Harvey Cushing, British Journal of Surgery.*)

OPHTHALMIC COMPLICATIONS OF INJURIES OF THE FACE.

Injuries to the eyelids, to the globe itself, to the visual structures within the cranium and to the optic nerve need surgical consideration. The severe lacerations involving total destruc-

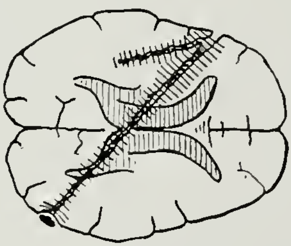


Fig. 54.—Diagram of tracks caused in brain by missiles in this case. (*Harvey Cushing.*)

FIG. 55.— Wound of orbito-temporal region with fragment of shell traversing brain and causing abscess in opposite hemisphere. Note position of entrance wound with drain after cranial exploration and suturing flap. (*Harvey Cushing, British Journal of Surgery, April,* 1918.)

tion of the eye as an organ of vision are hopeless so far as function is concerned. Plastic operation for concealing the deformity, or the adaptation of prosthetic appliances, is often required as a secondary method of treatment. The bringing together of such parts as remain, to reestablish movable eyelids and a globe to sustain an artificial eye, is a desirable primary object of surgery.

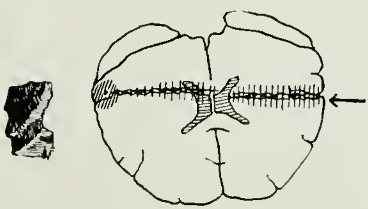


FIG. 56.— Diagram showing track through brain and missile, which weighed 0.9 grm., lying in middle of abscess. The missile is shown of natural size alongside of the diagram. Postmortem findings. (*Harvey Cushing.*)

A scratched or abraded cornea may be protected from infection by dissecting up a bridge or flap of conjunctiva and stitching it across the damaged cornea. Thus blindness may be averted in some corneal injuries.

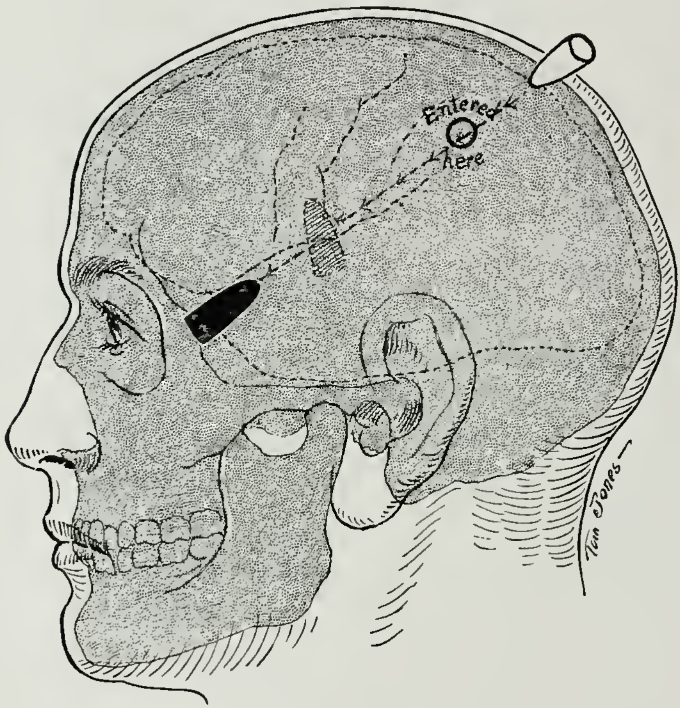


Fig. 57.— Penetrating bullet wound of brain. Entrancė wound very small, caused by nose of bullet. Note reversion of bullet after tumbling in the brain. (*From K. Speed Surgical Clinics of Chicago.*)

Cicatricial contractions resulting from loss of the soft parts, whether by avulsion or by necrosis, as occurs in burns, are familiar deformities in the domain of plastic surgery of the eyelids.

Marked extravasation of blood under the conjunctiva of the eyeball occurring a day or two after head injury, but not appearing in the eyelids until later, is very suggestive of fracture of the orbital plate of the frontal, or of the sphenoid bone. Subconjunctival ecchymosis, however, may occur as a result of a direct blow upon the eyeball, or from violent vomiting or coughing. Fracture of the malar or upper jaw bone may also cause the appear-

ance of blood under the conjunctiva of the globe. Fracture of the bony walls of orbital cavity may by displacement cause the eyeball to sink backward, thus creating an enophthalmos. Symptoms of aneurysm of the orbit, such as exophthalmos, pulsation and murmur, occur in injury to the internal carotid artery, or to the

FIG. 58.— Multiple wounds of face and both eyes.
(*Courtesy of Dr. H. W. Scarlett.*)

cavernous sinus and make fracture of the cranial bones probable. Occurrence a day or two after injury of ecchymotic spots below the mastoid process or near it tends to confirm the diagnosis of fracture of the base of the skull in the petrosal region. Prosthetic appliances may be made of metal and painted or enameled to represent portions of the face such as nose, eyelids, cheeks and ears and be supplied with artificial eyes of glass. These may be so

constructed as to hold their place firmly by means of spectacles, springs fitting into irregularities of contour, or by plugs inserted into nares or mouth. Many remarkably good repairs of lost tissues have been furnished soldiers suffering great disfigurement from ablation of large areas of the facial structures.

Cold water compresses to eyelids are effective in reducing inflammatory conditions from contusions and slight burns about the eyes. Superficial wounds from sand and gravel driven into the conjunctiva and cornea are frequent in trench warfare. Projectiles striking the sang bags on the parapets scatter the contents. These small particles should be picked out of the eyelids and eyes, and the conjunctival sac

FIG. 59.— Traumatic enophthalmos, patient looking straight forward; sunken appearance, resembling a badly fitting artificial eye, well shown. (*From de Schweinitz.*)

should be flushed with boric acid solution. About five to ten grains to the fluid ounce make a good eye wash for this purpose. Grains imbedded in the cornea may readily be removed with a spud or pointed cataract knife. Cocaine hydrochlorate in 1 per cent. solution will permit this little operation to be done without pain. Boric acid ointment or zinc oxide ointment is a favorite application for these gravel wounds of the skin about the eyes and nose, after the foreign body has been picked out. A weak tincture of iodine, say equal parts of the official tincture and grain alcohol, makes a good antiseptic and is usually better than such a watery or a greasy application. The skin surfaces heal rapidly if cleaned

and kept dry afterwards with only an occasionally used alcoholic antiseptic. Small abrasions and ulcers of the cornea are readily detected with a fluorescin solution. It may be made with fluorescin gr. viii solution of potassa fʒss, distilled water f℥i. Corneal perforations, if small, may be kept free from infection and caused to heal rapidly by stitching over them a flap of conjunctiva dissected from the sclerotic surface.

The use of atropia solutions in injuries likely to cause iritis with adhesions to the lens and other ocular structures must be remembered. Protection of the cornea from irritation by particles of dust and drying, when the eyelids have been destroyed in face wounds, is of immense importance. The general surgeon must not overlook precautions towards this end. The eyelids may be stitched together for a few days and thus protect the cornea.

Foreign bodies, such as steel fragments, shot and particles of stone, may penetrate the eyeball. If allowed to remain imbedded within globe, they not only set up a primary ophthalmitis, but they may bring about later the so-called sympathetic inflammation of the other eye. This calamity may be averted only by their early removal or enucleation of the eye originally injured. Localization with x-ray and removal by incision or the magnet require special ophthalmic skill.

Traumatisms of the eyeball may cause dislocation of the crystalline lens, rupture of the cornea or the sclerotic coat, tear or detachment of the iris, or intra-ocular hemorrhage. Puncture or rupture of the lens capsule usually results in development of soft cataract with possible swelling of the lens itself. In this case, intraocular tension is likely to be increased. Interference with intraocular drainage in the uveal region may lead to glaucomotous blindness from pressure due to the tension. This is an occurrence in wounds at the corneo-scleral junction. A trained ophthalmologist should be given charge of all these special eye conditions.

The changes in the fundus of the eye associated with "war nephritis," a better name than "trench nephritis," do not come within the domain of surgery. These cases have been found to be generally associated with exposure and strain; sometimes the result is prolonged general deterioration of health. Patches of exudation, small hemorrhages, retinal congestion and pulsat-

ing veins and evidences of nerve involvement are of great importance to the ophthalmologist. The albuminuria and retinal changes are due to an acute congestion; this is more probably allied to the acute retinitis of pregnancy, scarlet fever, and acute uremia than to the retinitis of chronic nephritis associated with permanent changes in the retinal vessels and the tissues.

Concussion in the occipital region may give rise to hemianopsia due to brain injury in the cortex near the posterior end of the calcarine fissure.

Fig. 60.— Method of plugging nose, for bleeding, with disks of sponge threaded on a ligature.
(*From Roberts's Modern Surgery.*)

NASAL COMPLICATIONS OF INJURIES OF THE FACE.

Wounds of the nose with or without fracture of the framework often give rise to partial or complete destruction of the external organ. Cicatricial occlusion of the nares and fibrous distortions demand skillful application of the principles of reparative surgery. Rhinoplasty in its various degrees must be called into play to make such patients presentable. As a rule, the average individual would prefer a fairly successful plastic restoration to a prosthetic appliance even of a highly artistic character. The great cost of metal or wax reproductions of facial organs and

their inconvenience to soldiers from the lower ranks of society make them frequently unobtainable. The newer methods of anaplastic operations give by repeated procedures quite satisfactory results. It is desirable that early attempts be made to sterilize and save all possible tissue by stitching the parts together soon after the receipt of injury. This early closure of wounds depends upon the prompt sterilization of the lacerated structures before contamination of the wound has been followed by infection. Excision of deeply bruised skin and muscle in the manner indicated by Carrel and the removal of comminuted bone and cartilage are less wise in wounds of the nose and face than in the limbs and trunk. Violent hemorrhage from the nose may require plugging. This is readily done by tying a piece of sterilized sponge on a string, pushing it back along the floor of the nostril, and then packing the nasal cavity with successive pieces of sponge threaded on the same string. This may be left in place for 48 hours. Fractures and dislocations of the nasal framework require adequate provision for reduction of the displacement and perhaps intranasal splints to prevent recurrence of deformity.

WAR WOUNDS OF THE EAR.

The surgeon should have some practical experience in using mirrors within the mouth to examine the pharynx, teeth and upper portion of the larynx, even though he cannot be expected to be skillful in laryngoscopy, tracheoscopy or esophagoscopy. A tongue depressor which will draw the tongue forward, a mirror small enough for examining the posterior nares, and a larger one for examining the glottis will be of service in serious injuries. This is especially true in injuries involving the posterior portions of the bones comprising the roof and walls of the mouth. The forefinger of the surgeon will also aid in determining the traumatic conditions of the nasopharynx and the adjacent regions.

In other words, a military surgeon should not be content with a mere superficial examination, when he is assuming the responsibility for gunshot wounds of the face and head. Bullets not infrequently penetrate the tissues of the face, ears and underlying bones. They may lodge in the anterior tissues of the cervical vertebrae, in the mastoid and other portions of the petrous bone, and the maxillary or orbital cavities. Blows upon

the occiput have been mentioned as giving rise to loss of a portion or the whole retinal field, causing total or half-sided blindness. Deafness may in a similar way be produced by labyrinthine concussion, sometimes with, sometimes without, injury to the tympanic region.

Projectiles may wound all parts of the external ear, producing considerable loss of portions of the cartilaginous framework, and even tear the auricle entirely away from the cranium. Necrosis or avulsion of cartilage, or perichondritis, may result in mere deformity or permanent mutilation. Extensive lacerations of the tissues surrounding the aural opening are liable to cause cicatricial closure. This may need plastic restoration by skin grafting or transferring flaps to improve audition or remove deformity.

Immediate and careful suturing will usually correct traumatic deformities, if there has not been absolute ablation of the structures of the external ear. The cartilaginous portions may be sutured. Cicatricial contraction causing deformity will be obviated by very early cleansing and readjustment of parts.

Bullets and other projectiles may enter the middle ear or be buried in the surrounding bone. The dura or the lateral sinus may be lacerated. Thus hemorrhage or septic complications may arise from aural injury. Meningitis, general septicaemia and brain abscess may occur as secondary results.

Perhaps it is best to perform an early operation for removal of imbedded bodies. When radiographic examination shows them within the brain, delay may be justified until a better opportunity for cranial surgery is obtainable. Infection of the mastoid process must, of course, be promptly managed by opening the bony covering over its cells. Treatment, in fact, should be that of mastoiditis from tympanic suppuration. Facial paralysis, labyrinthine symptoms and evidences of meningeal or cerebral infection should be promptly treated by the usual surgical methods.

Transverse fractures of the petrous bone are apt to involve the floor of the external auditory canal, the tympanum, the cochlea, the carotid canal and the jugular fossa. The symptoms are copious and prolonged discharge of cerebrospinal fluid with deafness, subjective noise, vertigo and nausea. Grivot says that

parallel fractures of the petrous bone ordinarily accompany fractures of the middle fossa of the cranium as a result of injury in the parieto-temporal region. The middle ear is involved in these lesions, with rupture of the tympanic membrane, and the line of fracture enters the walls of the tympanic cavity. Hemorrhage from the ear is copious and lasts for several days. Deafness may be present and vertigo absent, if the internal ear and acqueduct of Fallopius are uninvolved. It is difficult to develop these symptoms when the common damage causes unconsciousness. Labyrinthine injuries give rise to vertigo with nausea and deafness, probably due to hemorrhage, or other disturbing condition, within the labyrinth. Impairment of hearing may occur without direct traumatism from explosions acting upon the auditory nerve. This occurs from inhibition in a manner similar to that which takes place in smell and vision when the olfactory or optic nerves are subjected to prolonged and intense excitation.

The external ear may be lacerated very extensively and yet be molded into reasonably fair anatomical contour, if the tissues have sufficient connection with the circulation to be probably viable. Both the ear and the nose depend so much for their shape upon cartilaginous material that reconstruction by cartilage grafts or bone grafts is of great value in the successful restoration of contour.

Local subcutaneous emphysema in the mastoid region is diagnostic of fracture into the mastoid cells. A translucent pulsatile swelling of the scalp is indicative of escape of cerebrospinal fluid. It is a rare phenomenon and is conclusive evidence of solution of continuity in the cranial wall.

Bleeding from ear, nose, or mouth, to be of real diagnostic value in fractures of the skull must be profuse and continuous. Limited bleeding occurs from damage to the soft parts in these regions. The appearance of blood at an external orifice of the head, with symptoms of laceration of an intracranial sinus, artery or vein, is probably caused by fracture of the bony walls of these cavities and rupture of mucous membrane.

Escape of blood from the external ear usually means that the drum membrane is ruptured. Blood may come from injury to the internal ear alone or from the brain cavity. Sometimes when the petrous portion of the temporal bone is broken and the drum-

head not injured blood may pass into the pharynx through the Estachian tube, and thus escape by mouth or nose or be vomited after having been swallowed.

If an abundant, colorless, watery fluid with little accompanying hemorrhage flow from the ear, especially if it happen soon after a traumatism, it is probable that a fracture of the petrous bone has occurred with laceration of the tympanic membrane. If the flow is modified by the position of the head and by coughing, the diagnosis is almost certain. The fluid is cerebrospinal fluid and will be found to be highly saline and to contain little albumen. The escape of limpid liquid from the ear under other circumstances is of limited diagnostic value as a sign of cranial fracture. It may be Cotunnian fluid from the internal ear or blood serum escaping from a clot in the ear passages. Very occasionally cerebrospinal fluid escapes from the nose or mouth because of fracture of the spheno-ethmoidal portion of the anterior fossa, or of petrous fracture without rupture of the tympanic membrane. The Eustachian tube furnishes the route for the fluid passing into the pharynx and hence out of the mouth or nose because in the case under consideration the tympanic membrane is unbroken.

The facial, auditory, optic and olfactory nerves may show paresis or paralysis immediately after the head has been injured because of laceration of the brain near the origin of the nerve, of hemorrhage within the nerve sheath, or of pressure within the nerve's bony cavity or canal. It is very suggestive, however, of fracture of the base of the skull with simultaneous injury to the nerve trunk itself. Displaced bone or a clot may be the source of pressure causing sensory or motor disability.

The complications arising in gunshot or other war wounds of the face by reason of coincident damage to eye, nose, mouth or ear must be managed by resort to the special means demanded by the character of the injury. Head mirrors, the ophthalmoscope, and the methods of examination familiar to oculist, otologist, rhinologist and laryngologist must be employed. It will often be necessary to obtain the services of specialists in diseases of these organs for diagnosis and intelligent treatment.

SURGICAL SHOCK IN FACE MUTILATIONS AND COINCIDENT INJURIES.

The symptoms, to which the term shock has usually been applied, occur immediately after severe woundings of the facial bones and soft parts; and especially when simultaneous traumatisms of other regions take place.

The term surgical shock should not be permitted to include all cases of death occurring promptly after injury, in which no definite microscopic changes are discovered at autopsy. Many symptom complexes formerly, and perhaps at present, denominated shock, may have been instances of anaemia from primary hemorrhage, fat embolism from crushed bone marrow or from injured adipose tissue of other regions, or rapid absorption of septic fluids. Perhaps rapid abstraction of heat from abdominal organs may be the real cause of the grave depression or death in some cases of operative shock.

The so-called delayed shock, sometimes described, seems to be a misnomer; and I believe it to be usually, if not always, one of the conditions just mentioned.

The complete recovery not infrequently seen after even profound shock shows that the microscopical lesion must be one susceptible of repair, whether it be situated in the cerebro-spinal or sympathetic nervous system, the circulatory, or in some other vital function. The investigations of Watson, Crile, Bessing, Porter and others have not as yet given an altogether acceptable pathology. Extensive fat embolism, studied years ago by Wagner, Busch, and Scriba as a cause of death through plugging of pulmonary, renal and cerebral capillaries, has recently been revived by W. F. Porter, of Harvard University, as at least one cause of shock. He investigated the subject with scientific zeal at the battle front of the present European War. He reached the conclusion that the wounded men with shock seen by him were the subjects of fat embolism; and suggested enforced breathing of carbon-dioxide as beneficial in the treatment.

If I understand his description of the circumstances under which he saw the patients, he did not come in contact with them until a considerable number of hours had elapsed after the receipt of the gunshot or other wounds. If this be so, is it not possible that his cases were different from those in which surgeons see shock exhibited

within a few minutes or an hour, let us say, after the traumatism has occurred? In a clinical contribution to the subject written years ago I collected some data from experimental literature showing that "delayed" shock was a misnomer and that fat embolism had as one of its points of difference from true surgical shock its later arrival in the patient's sympatomatology. See Packard's American Edition of Holmes's System of Surgery (1881), vol. I, p. 143.

It is recognized that surgical shock is greatly influenced in degree by individual susceptibility, by location of injury, by sex, age, and by previous disease or condition of the wounded. It may well happen, therefore, that soldiers exhausted by anxiety, fatigue, loss of sleep, and horror at their personal disfigurement, show grave shock after severe facial mutilation. The mental depression would doubtless aid in the establishment of the lowered vital energy which causes the prostration, pallor of surface, clammy sweating, shrunken countenance, low temperature, feeble, frequent pulse, shallow breathing and the languid response to questions. Longmore, Weir Mitchell, Howell, Henderson, Crile, Meltzer, Porter and other physiologists and surgeons have given much attention to the pathology of surgical shock. It is probable that the term "shock" should be abandoned; because several pathological entities with similar terminal symptom complexes have been included in the term. Lowering of the alkali reserve in the blood after anaesthesia and operative attacks and the beneficial effect of intravenous use of alkaline solutions have seemed to indicate a possible relation between shock and acidosis. Crile's belief that shock is an exhaustion of the vasomotor center has been contested by Meltzer. The latter authority doubts that fatigue of nerve centers is the cause of the lowering of blood pressure, which is so evident in shock from traumatism. Although lowered blood pressure precedes death from shock, it is important for the surgeon to know what starts the diminution of the blood pressure and how to prevent the initial activity of this cause. Henderson and Haggard see a suggestive cause of surgical shock in a connection between the excessive respiration due to pain and the carbon-dioxide capacity, or alkali reserve, of the blood. Loss of vaso-motor control is asserted by some investigators to be a very important factor in the production of shock. Shock following severe burns is probably toxic

in its nature. Meltzer opposes the view that acapnia, acidosis, or fat embolism is the cause of surgical shock.

More important in war surgery than discussion of the physiological nature of shock are the questions of prevention and treatment. Avoidance of a fall in blood pressure, prevention of pain, and control in severity of traumatism are to be insisted upon as prophylactic measures. Blood pressure must be maintained; hence, hemostasis is paramount. Anaesthesia should not be allowed to reduce blood pressure nor should it be toxic to a dangerous degree. Ether, although the safe anaesthetic for general use, is not always given in a manner to fulfil both these conditions. It is toxic to nerve tissue and glandular organs and reduces blood pressure also. Janeway and Ewing assert that, unless administered with great care, it strongly reduces blood pressure. Nitrous oxide is safer in both directions and with associated nerve blocking may perhaps finally surpass ether in usefulness.

Porter's observations in the European War prove to his satisfaction that low blood pressure is much more common in wounded soldiers than generally is believed by military surgeons. He states that fatalities may be greatly lessened by efficient treatment; and bases his therapeutic methods upon results in laboratory work and his experience with wounded men at the front. He has found that a diastolic blood pressure of 45 to 50 mm. continued for a considerable time means that a laboratory animal will die of shock, unless saved by surgical treatment. The experimental animal, it is asserted, bleeds to death into its own portal veins, whenever accumulation of blood in the abdomen reduces the diastolic blood pressure to or below the critical point of 50 mm., unless prompt remedies are provided.

His assertion is that there is no essential difference between men and other animals in this low blood pressure criterion; hence remedies that are successful in raising the blood pressure of one are to be adopted by surgeons for the relief of shock in the other. The wounded soldier, therefore, should have his blood pressure raised above the danger point by the aid of gravity, intravenous injection of sterile normal saline solution, and the resort to adrenaline. The supine position with the feet 30 cm. higher than the head should be maintained until diastolic pressure will remain close to the normal level. An hour or more may be

needed to produce this effect in moderate shock. In graver emergency, the diastolic pressure should be raised promptly to 70 or 80 mm. by injection of normal salt solution into the venous current. The adoption of the hydrostatic saline injection should not be delayed; but the current flowing into the vein should be slow and continued until a pressure of 80 mm. has been reached. When the pressure falls again, adrenaline should be given intravenously, preferably into a vein near the ankle. The test of sufficient venous medication is that the action of gravity has become able to maintain a safe blood pressure level.

The surgeon must remember that in very low pressure accompanied with persistent oozing of blood, and in which operation cannot be considered as an immediate remedial procedure, large injections of saline and adrenaline solutions may increase hemorrhage, by raising the general blood pressure. Transfusion of blood should take the place of saline phleboclysis. This operation may carry the patient over the crisis and enable the surgeon to apply hemastatic pressure or ligatures to the bleeding points. use of sodium citrate render transfusion more available than was formerly the case. Blood may be kept in cold storage and used when needed.

Porter says that gravity is a most important agency in the treatment of shock. His words seem to indicate that he considers death inevitable in serious cases of perforation of the thorax, which prevent the low chest posture because it leads to asphyxia. In addition to the remedies already discussed external heat is of highest importance. Surgeons have long been familiar with the employment of heat. A hot bath might be employed while gravity and saline solutions are being used, provided its administration did not disturb the patients by the necessary movements. The wounded in shock must be kept hot, quiet, and have blood pressure raised to about 80 mm. Autotransfusion by bandaging the extremities may have value in increasing the general blood pressure. Prevention of escape of blood from oozing points by applying firmly a broad elastic bandage directly over the pulpefied tissues, has value in military, railroad, and machinery amputations and crushes. It should take the place of the not unusual rubber tourniquet applied near the trunk by many thoughtless attendants. Taking the diastolic blood pressure as frequently

as every half hour is almost imperative in serious shock. Its information surpasses in value that obtained from frequent temperature investigations.

Porter uses a heated table under the supine patient whose feet may be readily raised 30 cm. higher than the head. This insures that the abdomen is higher than the heart and brain. The wounded man is kept in the inclined position an hour or two or even more; and the diastolic blood pressure raised promptly to 20 or 30 mm. above the critical point previously mentioned. If normal saline is being employed as an intravenous remedy, it should be discontinued when the diastolic pressure reaches 80 mm. If there occur a secondary drop of importance in the blood pressure, which is not improved by a second phleboclysis, intravenous injection of saline solution with adrenalin is advocated. Porter uses this remedy by means of a venous puncture near the ankle. He desires to raise and keep up blood pressure until gravity maintains a safe level.

Fischel has objected to the use of adrenalin and petuitrin in shock unaccompanied by hemorrhage; and advises in such cases vasodilators instead of vasoconstrictors with the usual employment of heat to the patient's surface.

The temperature of solutions used should be 38° C. when sent into the venous channels, and about 500 cc. is usually as much as is desirable at one time. A slow entrance of the solution lasts about ten minutes. The third injection should be the one to contain adrenalin and should slowly flow into the vein for about ten minutes. When diastolic pressure reaches 80 mm., the flow is discontinued. Fischel has objected to the use of adrenalin and pituiatrin in shock unaccompanied by hemorrhage, and advises in such cases vasodilators instead of vasoconstrictors with the customary application of heat.

The surgeon should not overlook the value of the alkaloids found in opium and belladonna in treating shocked patients. Both have seemed to be clinically serviceable in some forms of the grave depression usually included in the term surgical shock. Obtunding pain, relieving fright and anxiety and inducing rest in sleep by morphin have surely some therapeutic virtue. Atropin also has had many advocates, perhaps used as a companion of morphin, its physiological antagonist. Strychnia in moderate doses may serve to carry the patient over a period of collapse.

It should not be used in such large amounts as to exhaust the vital forces by an unwise desire to " whip up " the vital energy of the patient too rapidly. The forced inhalation of carbonic acid gas has seemed applicable to the cases studied by Porter in the War Zone. Meltzer seems not to favor this remedy.

Surgical shock must be differentiated from the much discussed " shell shock " of recent literature. This symptom complex, so frequent in the trenches of France at this time, probably, is due to deep exhaustion of mind and body from continued fatigue, to hysterical conditions in the psychologically infirm individual, and to various neuroses of traumatic origin. It is said that prisoners who have been delivered by capture from the strain of trench life, and badly wounded men do not show the "shell-shock" complexus.

Geoffrey Marshall, who has studied surgical shock in connection with anaesthesia, terms it a condition which evades exact definition. Its causes, he says, are almost invariably injuries which are severe from involving important structures or from having invaded extensive areas of tissue. The symptoms in a typical case are a dusky pallor of the face, flickering or an imperceptible pulse, low surface temperature, and repeated vomiting, with little mental disturbance. The patient may be fully conscious and intelligent up to within a few minutes of death. The blood pressure, when taken in the brachial artery with a Riva-Rocci sphymomanometer, is often higher than would be expected from the character of the pulse as determined by palpation of the radial artery at the wrist. When the shock symptoms are profound, the systolic pressure is usually below 80 mm. of mercury. The blood in the capillaries of the extremities is dark and of a cyanotic color. He has found in shock cases without hemorrhage the blood more concentrated than normal.

Shock should be lessened by treatment before even urgent operations are attempted. External warmth commonly produces definite improvement. Hot water and coffee decoction used as an enema has distinct value. It should be associated with rest in bed. Gradually the temperature rises, the color improves, and the arterial blood pressure goes up. I believe that time is an important element in obtaining this improvement.

According to Marshall, subcutaneous infusion of saline solution produces no measurable effect in this type of shock. This is shown by the fact that, if death occurs so late as 30 hours after such injections, most of the solution will be found still unabsorbed in the subcutaneous tissues. Even intravenous injection of normal saline solution given before operation is of little value. It may cause a temporary rise of blood pressure and slow the pulse rate, but it does not prevent the occurrence of further shock from the operative attack. The blood pressure falls at the moment operation is begun.

Transfusion of blood done towards the end of an operation is beneficial. Hypertonic saline is better than normal saline solution. These remedies thus given cause a more lasting elevation of blood pressure with slowing of the pulse. Marshall ventures no opinion as to the value of artificial viscosity given to the transfused solution.

That patients in serious depression from sepsis stand anaesthesia and amputation better than those depressed by shock is the experience of Marshall. This is in accordance with the opinion of general surgeons. The septic cases, he thinks, do well under anaesthesia from gas and oxygen, and that warm ether vapor by inhalation, intravenous ether, are comparatively safe. Chloroform, he says, should be avoided even in septic cases.

These deductions of Marshall may perhaps be drawn without sufficient recognition of the variation in the degree of shock which existed in cases studied by him.

It must be remembered that in warfare the evidences of shock in the wounded man may be greatly increased by exposure after injury, by fatigue, anxiety and want of food prior to battle. Cold, loss of blood, pain and mental depression, while lying on the field of combat, exposed to the elements and to repetition of injury, and the distress of transportation, must deepen the depression of vital forces. Time is therefore an important factor in comparing cases of shock, whether one be studying the symptoms or the relative value of methods of treatment.

Warmth and rest are more important than food, but the last in small quantities and easily assimilated has a bearing on the reaction from shock. Time is of supreme value in the opinion of many experienced surgeons.

It is interesting to hear from Charles L. Gibson that "the generous use of anodynes prior to operation has a marked effect in diminishing shock." This testimony, from the battlefields of France to-day, coincides with the statement of Savory made nearly fifty years ago that "a few hours sleep will sometimes altogether change the condition of the patient." The civilian surgeons of to-day who forbid morphin and water to patients after operative attack on abdominal and pelvic organs would do well to heed those words of two experienced writers. Heat, rest, and water to fill depleted blood vessels are cardinal rules in the treatment of shock where pain, vital depression and hemorrhage are combined.

CHAPTER VI.

RADIOGRAPHIC DIAGNOSIS IN WAR INJURIES OF THE FACE.

Fluoroscopic and radiographic evidence of the location of foreign bodies in the organs and tissues of the face may be of supreme importance in the therapeutics of war injuries. The necessity of early extraction of portions of metal within the eyeball cannot be overestimated, nor can the value of the removal of bullets and other missiles from the face for the prevention of sepsis.

An accurate knowledge of normal radiographic appearance and normal anatomical variations in the face and head is of undisputed worth. The surgeon should study radiograms of these localities and organs under varying conditions. He should know by personal observation the probable lesion and situation of the projectile prior to the exposure of the patient to x-ray examination. He should also have a knowledge of the manner in which the x-ray plate was made. He must remember also that a distinct change may take place in the relation of fragments of a fracture, for example, or even in the situation of a projectile from day to day. It, therefore, is important that the surgeon should add the clinical appearances to the radiographic and fluoroscopic evidence before acting upon the latter when an important diagnosis is to be made.

Radioscopy, after all, must always be taken in conjunction with other observations and clinico-diagnostic methods of examination. It is deviation from normal shadow effects, caused by variations in transradiancy of structures, that gives the key to the situation of metalic projectiles, displacement of broken bones and dislocated joints and abnormalities in teeth. While radioscopy alone may sometimes determine the diagnosis, it is more likely to modify, define, or confirm the conditions previously recognized by other methods of examination. It may, however, give an earlier radiographic proof of disease in bone and other tissues than is furnished by the clinical means of differential diagnosis.

Radiograms by giving negative evidence may prove of value in war surgery by excluding the possibility of lead or other metal being embedded in tissues far from the external surface. Military surgeons, however, must recollect that septic pieces of clothing, which are more dangerous even than metal fragments, usually show no shadow on the x-ray plate or beneath the fluoroscopic screen. Experience has shown that missiles may do less damage, if permitted to lie embedded in the structures of the head and face, than if removed by operation. This can scarcely be said, however, of portions of septic clothing. They are the great cause of deep abscess and secondary septicaemic disaster.

It is always safer to study the radiogram than a print made from it. The position in which the photographic plate should be put, to obtain the best view for localizing foreign substances within the tissues, should in careful work be determined by a previous fluoroscopic inspection. The irregular contour of the head and face and the consequent difficulty of getting two radiograms in planes perpendicular to each other make localization more difficult than in the limbs. It is wise, therefore, not only for the surgeon to be familiar with the shadow values of the facial structures in various positions, but to study each case under investigation in several directions by fluoroscope before the radiograms are made. The greatest difficulty, perhaps, occurs in studying fractures of the maxilla and mandible. X-ray plates of the lower jaw particularly are confusing, unless a very small one is placed within the mouth before the corresponding surface of the face is rayed or screened. One side of the mandible can thus be radiographed without interference from the shadows of the opposite side.

The shadow picture of the normal anatomy of the bones of the face of adults of different ages should be known and compared with the x-ray findings in the injured patient. A difficulty sometimes arises from not knowing which is the right and left side of the plate or print. It is good practice to mark these at the time the exposure is made. It must be remembered also that the print is a positive taken from the radiographic plate as a negative. This reverses the right and left sides. Translucent parts are, of course, darker on the radiographic plate, but light on the print. These statements are made to recall the fact to the inex-

perienced examiner of x-ray plates and prints. They are, of course, familiar to all persons accustomed to examining such radiographic results.

X-ray pictures of the sound side of jaw or uninjured eyeball or socket should be used as a control, when studying doubtful injuries, making careful localization of foreign bodies or seeking abnormalities in structure. It has been recommended that a screen view be taken in order to find the best position of the tube and to have it properly centered in localizing examinations. A screen view alone should never be relied upon to deny the presence of a fracture, for example, if there is pretty positive clinical evidence of the existence of a solution of continuity in the bone. All suspected fractures should be investigated by x-ray plates taken in two planes as nearly as possible at right angles to each other. Spontaneous fractures from softening of bones and fractures without displacement in the extremities were often undiscovered before the adoption of x-ray investigation. Such injuries may still be missed if a mere fluoroscopic examination or an exposure in one plane only is accepted as evidence of no break.

If possible, the military surgeon should, in addition to familiarizing himself with the shadows of normal structures of the head, adopt a standard position in which to take x-ray plates, when examining the different parts of the cranium and face.

Maxillary and mandibular fractures, temporo-mandibular dislocations, rarefactions and sclerosis of bone and periostitis may be revealed and progress of the condition from time to time determined by radiographic study. Necrotic pieces and the occurrence of abscess may also be disclosed by radiograms. In acute periostitis a wavy line will probably be seen separated from the bone. In acute traumatic periostitis, a similar condition will be evident, with perhaps laceration of the periosteum instead of its simply being lifted from the bone by the exudate beneath it. Pus between the periosteum and bone gives a denser shadow than a serous exudate. Sclerotic bone gives a denser shadow than normal bone; that is, on the plate it is lighter than normal bone; in the print, darker. Chronic periostitis will show a thickened line or shadow some distance from the normal shadow of the bone itself. The cause of the periostitis must be determined by clinical evidence and history of the case. Cystic tumors of

the facial bones and malignant disease have characteristic appearances which require careful study. Those who are expert in radiography will be able, but perhaps only after frequent examinations, to differentiate malignant disease from tubercular conditions and from syphilitic and other inflammatory states. These affections, however, do not concern us very much in this study of war injuries. The chronic changes which take place after gunshot and other wounds render it desirable that the military surgeon should spend time in the study of these conditions by radioscopic and fluoroscopic investigations.

Blood in the tissues gives a very dense shadow with irregularly shaded margins. Pus is usually more circumscribed than blood or a serofibrinous effusion. A mere serous effusion in the tissues may be suspected when the soft parts are distorted by the pressure of the fluid between them. Unusual shadows in abnormal situations may lead the observer to suspect fibrous adhesions, particularly about joints. X-rays, however, do not give sufficiently positive evidence of these fluids being within the subcutanous tissues to warrant operation. The clinical signs must be resorted to as corroborative evidence.

It is the localization of buried foreign materials that most frequently leads the military surgeon to call the roentgenologist in consultation. Although many missiles may be left to become encysted even in the brain, a record of the anatomic situation of these penetrating bodies is very desirable. Intelligent cooperation between the roentgenologist and the surgeon with a good x-ray outfit will often result in obtaining a wonderfully accurate determination of the anatomic situation of a fragment of missile. This statement is particularly true in minute particles of steel or lead carried by gunshot propulsion into the orbit and globe of the eye. The importance of removing even a small fragment from the interior of the globe made skillful localization by the x-ray method an early ophthalmic reality.

Similar methods to those used by ophthalmologists years ago have been developed and modified, so as to apply with almost equal success to the localization of objects in the face itself. Many surgeons, civilians as well as military, fail to realize the distortion which may occur in x-ray plates and prints due to carelessness in accurately placing the tube over the center of the

part to be x-rayed. In bilateral regions both should be studied, so as to have a control of the uninjured side with which to compare the possible variations occurring in the injured region. Divergent radiation from the x-ray tube causes a distortion of shadows and a disproportion of size. This is often overlooked. It has been truly said that in a radiogram of large area the central parts of the plate may be represented with some degree of accuracy in relative size and localization relations, but the marginal parts of the plate will be so magnified and distorted as to be of little if any real value. By using a diaphragm to cut off the external divergent rays there will be less marginal distortion. This device is, therefore, often used now in radiographic work. It must be remembered, then, that the dimensions of shadows are not an index of the dimensions of the objects casting the shadows.

More detail will probably be obtained by avoiding too short exposures. The plate should be as near as possible to the foreign body looked for. The patient must be perfectly steady and the apparatus free from vibration. As I have said previously, the surgeon should adopt standard positions for studying definite parts of the face and head. By frequently examining normal persons, he should become acquainted with anatomical variations and shadow effects. Thus he will correlate anatomical knowledge and structural relations with fluoroscopic and radiographic images. It is needless to state that metal splints, lead salts in adhesive plaster, strips of metal to strengthen gypsum appliances are impermeable. They, therefore, hide the shadows of projectiles, bones and teeth. Even dressings containing lead, mercury, bismuth, and iodoform act in a similar manner by creating more or less dense shadows. It is said that the absorption of some of these remedies by the skin may interfere with the definition of radiograms. Some of these interferences may be lessened by using a hard tube; that is, a tube with a high vacuum, and setting it closer to the patient.

The anticathode of the x-ray tube should correspond exactly with the center of the region to be examined and the central point of the plate. The center of the region should be determined by a previous screening of the patient, when this is practicable. The part to be examined should be next the plate, which

is to be laid upon a flat board faced with lead. These details can often be best obtained by having the x-ray beneath the patient. He should lie on a table in which there is a square opening over the point where the tube is placed. By this position of the tube a previous screening may be readily made to determine the picture and have the plate properly centered. This is not so conveniently done if the tube be placed above the patient. A satisfactory fluoroscopic view of the part of the face which is especially desired for record may thus be obtained by moving tube or patient and adjusting the diaphragm to suit the anatomical necessities. Restriction of area by the use of the diaphragm excludes circumferential rays and therefore gives a better definition of outline and a finer detail of tissues. The marginal oblique rays and the irregular rays emanating from the glass walls of the tube that may confuse the image are thus excluded. When a large area is necessary in x-ray pictures, it is better to take two separate radiograms and put the tube central to both. These views can then be placed in proper apposition for complete study or printing. Especially sensitized photographic plates may be used rather than ordinary photographic plates, when it is impossible to use the radiographic plates themselves for localizing study. These give greater density to the images and furnish the examiner with more definite pictures than the ordinary photographic paper. Whether the tube is placed above or below the patient makes no special difference, but the plate should be horizontal as nearly as possible and the region to be rayed must, of course, be between the tube and the plate.

Usually the surgeon confides all the details of producing radiographic records to a skilled operator. He must, however, confer with such experts often enough to obtain a practical knowledge of the results of x-ray exposure and screening in the human body. The interpretation of one who is simply either a surgeon or a radiologist is seldom, if ever, infallible. The combined experience of the two in reading x-ray plates is much more likely to be confirmed by operative findings. There are means of obtaining better results and even of improving plates while developing and fixing them; these fall within the domain of the radiologist.

The protection of those using the fluoroscope and those working in x-ray laboratories for localizing or diagnostic purposes

must also be insured. Bromide powder makes particularly good prints of radiograms. The question whether the prints should be made by artificial light, and similar technical details do not belong to the surgeon's part in the examination. Reductions from radiograms or lantern slides furnish probably most satisfactory permanent records of the results of radiographic studies. The plate should be examined in a shadow box, if detail or differentiation the shadow values is a matter of importance. A considerable experience with studying radiograms has convinced me that much of the work done in hospitals is defective in a number of these seemingly minor details. The right and left sides of the patient must be kept in mind. These points are reversed in making a photographic print from an x-ray plate because in printing the film side is turned toward the paper and away from the light. Dimensions of shadows are not actually or relatively the dimensions of the objects causing the shadow created by the x-ray. The size of the shadow made on the x-ray plate is increased with the distance of the object from the plate. An object nearest the plate casts the smallest shadow and also produces the most clearly defined shadow, when compared with the shadows of more distant objects having the same degree of transradiancy.

To give a true conception to the mind of the observer of the relative positions of structures and of embedded foreign objects stereoscopic views are necessary. The conception of solidarity arises then from a super-position of the visual images received by the observer's two eyes. This principle is well recognized by us in stereoscopic photography. Stereoscopic radiograms are made by moving the x-ray tube and taking two successive plates with the patient in the same position. The tube is moved laterally about an inch and a half from the central point of the region under stereoscopic study. The stereoscopic plates are then viewed in a special apparatus, which need not be described. It is important, however, to remember that, if a stereoscopic apparatus with mirrors is used, the right and left sides change from the relation they occupy when the direct method of stereoscopic examinations is employed. If small prints are made from the stereoscopic radiograms, a hand stereoscope is satisfactory for the examination. In studying the position of foreign bodies and

viewing radiograms of teeth this small stereoscope answers very well.

It is fortunate that in war surgery nearly all foreign bodies, the exact position of which needs to be determined, are dense to the x-ray. They, therefore, throw deeper shadows than the organs surrounding them. Glass, except that made with potash, and all metals cast a marked shadow. Paper, cloth, leather and wood, however, cannot be visualized when buried in the body. Sometimes pieces of clothing and military equipment, other than things made of metal, may be suspected from the blurring of the outline of the tissues between them and the tube. It is unwise, however, to say that such articles are absent from the part being rayed because no shadow is seen.

The surgeon who is to remove the projectile expects the radiologist not only to show the existence of the foreign material but to determine its relation to well-known anatomical landmarks. The anatomical relation of an immovable foreign body remains unchanged with varying positions of the patient. Radiographs of embedded metal and those of neighboring bones or teeth alter their radiographic relation to each other when the patient's position is changed.

The localizing means employed in war are not new. They are adaptations or improvements devised to meet the emergencies of warfare. The crossed thread method of localization is probably the method of choice where precision is desired. Stereoscopic examination of plates taken with the tube, placed as would be the position of the two eyes in binocular vision, will sometimes be satisfactory to the average surgeon. The fluoroscopic screen examination often aids very much in the search for a buried projectile. Frequent reference during the operative work to radiograms taken in two planes gives helpful localizing data.

In describing lesions connected with, or in the neighborhood of the teeth, it is well in military reports to describe the teeth by number rather than by the anatomical names. The teeth of the upper jaw are numbered from the third molar on the right side of the mouth around the arch to the left third molar. This makes sixteen. The number 17 is given to the third molar on the *left* side from which the numbering proceeds in reverse direction in regular order around the arch to the third mandibular molar

on the right side, which receives number 32. The reader will observe that this numbering makes the first tooth opposite to the thirty-second.

The superiority of localization of lodged missiles by the use of x-rays is so great that it is used to the practical exclusion of all others. Radiology helps not only conservative surgery by giving information without disturbance of the wound from immediate attempts to locate missiles, but when properly used is so exact that it facilitates radical operative procedure. It naturally requires good surgical judgment to determine when, and when not, to proceed to operative extraction of penetrating projectiles. The attempt in former times to locate a bullet, by means of the porcelain tipped probe or the simpler metal tipped probe, was often more successful in rendering the tract septic than indicating the spot towards which operative effort should be directed.

After the location of a lodged missile has been determined by the roentgenologist, its tract can safely be left undisturbed, if the danger of immediate removal seems more perilous than operative delay or permanent retention. Even the telephonic probe which at one time had a certain vogue, is far outclassed by the localizing efficiency of x-ray examination. The fluoroscope and radiographic methods in many cases should be used in association.

Operative surgery is founded on the relation of the various anatomical structures to one another. It aids the surgeon, therefore, greatly, to be informed of the relation of the buried projectile to those anatomical landmarks which he habitually uses as guides in deep dissection. What he desires, therefore, from the radiological investigation is the distance from certain bony landmarks or a proximity to recognizable organs, muscles or nerve trunks. It may happen that the radiologist will be more interested in giving the number of centimeters from the surface and the lateral distance from some object in another plane. These two identifying factors, the anatomical and the mathematical, may give much more valuable information, if used in association than if either one alone is depended upon. If screen examinations are to be used, the observer must be particularly careful, by use of lead and rubber protection, to obviate personal injury from prolonged exposure to x-rays. The screen examination

made in two positions at right angles will permit a mark to be made with a pigmented pencil or nitrate of silver upon the skin. showing where the two perpendiculars projected into the tissues would intersect. The x-ray tube must be carefully centered and the diaphragm contracted; after which the tube should be moved laterally under the luminous area until the shadow of the object occupies the exact center of the illuminated skin. A metal ring with crossed wires in the opening may be placed under the screen and moved until the right angle intersection of the wires corresponds with the shadow of the buried metal. Such a wired ring makes it easy to mark the skin at the spot under which lies the foreign body. Flexible bands of lead may be molded around the part being examined to aid in reconstructing the cross section of the region in which the body is situated. This is done after marking the lead with a dot over the shadow in two or more planes, removing the band carefully without distortion, reconstructing a cross section or placing the band on a cadaver and prolonging from the marks on the lead the lines indicating the routes of the localizing ray.

Another means of localization is to measure the movement of the shadow of the foreign body on the fluoroscopic screen when the tube is moved so as to change its relative position to the foreign body. By a mathematical calculation, this parallax method gives the depth of the foreign body beneath the screen. Localization by triangulation will also give the depth of the foreign body from the surface of the screen by noting the movement of the shadow caused by moving the tube through a known distance along a fixed route. These three methods, namely: the cross wire, the parallax and the triangulation, are justly favored by workers in the localization field.

Fluoroscopy is less frequently resorted to by surgeons for localization than is the study of radiographic plates. As has been described in an earlier part of this chapter, radiograms are liable to give erroneous information and are valueless unless several plates are taken in planes at known angles. There should be at least two, and these should be in planes at a right angle to each other. Stereoscopic plates have been discussed and the surgeon can gain quite satisfactory information from thus study-

ing, in its three dimensions, the relations of the discovered missile.

Various mechanical devices have been constructed to utilize the principles mentioned. In locating foreign bodies within the eyeball the so-called Davidson crossed thread localizer is one of the most exact and useful apparatuses. It is only in localizing particles of steel or lead in the cranium or eye that great mathematical accuracy is required. In other regions, a moderate error is easily compensated for by a careful dissection at the hands of a surgeon with a good knowledge of anatomy.

It is sometimes difficult to place the patient during an operation in the exact position he was made to assume during the x-ray examination. It may not be possible for the surgeon to reproduce this position and place his incisions in exact compliance with the direction of the radiographic rays. The depth reading from radioscopy should, if possible, be combined with a statement from a trained observer of the anatomic position of the foreign body. Associated action of the surgeon and the roentgenologist will usually, when time permits, work out with sufficient accuracy, the needful result. It may become necessary to use fluoroscopic screen views during operation to enable the surgeon to orientate his operative incisions and efforts. This method of gaining access to embedded bodies for their removal resembles the reduction of fractures of the extremities by using a fluoroscopic screen during manipulation on the etherized patient. It is possible that mandibular fractures may occasionally require this sort of roentgen ray assistance for the proper replacement and fixation of fractures in the vertical ramus or condylar region.

CHAPTER VII.

HEMORRHAGE.

The frequency of contamination and septic infection of the severe facial wounds of military surgery makes the problem of hemorrhage vitally important. Control of primary bleeding previous to sending wounded away from the casualty stations at the front is usually forced upon the attention of the military officer by the anaemic appearance of the injured man and the character and situation of the wound submitted for examination. It is the possibility of intermediate or of secondary hemorrhage occurring during transportation to the casualty clearing station or the base hospital that must be realized by every surgeon, under whose care the wounded soldier or sailor comes for treatment.

Traumatic hemorrhage is primary when it immediately follows the receipt of wound; intermediary, when it occurs after reaction from the shock of injury and before the lapse of twenty-four hours; and secondary, when it takes place between the end of the first twenty-four hours and the completion of cicatrization of the wound.

Intermediary, often called recurring, hemorrhage arises because the force of the circulation has, from the establishment of reaction, become sufficient to displace the clots which, during the previous condition of feeble circulation, prevented bleeding.

It may, therefore, occur from small vessels that did not, at the time the wound was dressed, seem to demand ligatures or other treatment; or from larger ones, to which ligation, torsion or pressure was carelessly or imperfectly applied or in which the wound was so small that no hemorrhage supervened until the circulation had fully regained its force.

Secondary hemorrhage may be due to any constitutional condition, such as hematophilia, septicaemia, pyaemia, hepatic disease or renal disease, which interferes with the plastic changes and organization of the internal clot that constitute Nature's method of permanently sealing wounded vessels. Hence, when the ligature is absorbed or the wall of the vessel ulcerated through at a point of ligation, bleeding supervenes.

Secondary bleeding may also be caused by an unrecognized

contusion or abrasion of the vessel wall which has subsequently given away at the injured spot by failure of the surgeon to secure the distal end of the artery or to tie a wounded branch situated just above the ligature. In the last two instances the establishment of the anastomotic circulation may be followed by bleeding. Sloughing in the wound, atheroma of the arterial wall, septic processes due to septic ligatures or dressings, badly applied ligatures, premature softening of a ligature, and the rush of the blood-current through a large branch given off just above the point of ligation are usual causes of secondary hemorrhage. Secondary bleeding usually does not occur earlier than one week, or later than three weeks, after the time of injury or operation. Septic causes are responsible for the majority of cases of secondary hemorrhage. Aseptic hemorrhage in civil practice has made secondary hemorrhage rare. It is comparatively frequent in the military services because of the necessary difficulty in applying or obtaining aseptic treatment during battle emergencies.

The occurrence of profuse secondary bleeding is generally preceded by a slight flow of blood, which, when observed during the progress of cicatrization, should always be looked upon as a warning of grave import. There may be several slight hemorrhages from the wound, and then a profuse bleeding which may quickly destroy the enfeebled and anaemic patient.

Blood starts from a wounded artery in a rapid stream, and, as each beat of the heart gives an increased impulse to the blood-current, the jet gains force and is propelled further synchronously with the cardiac pulsations. The blood is of a bright red color, unless the patient is deeply anaesthetized or partially asphyxiated; then respiration and oxygenation are imperfectly performed, and the blood is dark. When an artery has been completely divided, the hemorrhage from the end further from the heart may not be rhythmical until the collateral circulation is well established.

Venous hemorrhage is characterized by a steady flow of dark blood, which is not affected by the heart's action. The stream may show a tendency to rise and fall in a sluggish manner with each respiratory act, but never spurts. If the bleeding occurs at the bottom of the wound the blood may become reddish from admixture with air before it reaches the surface.

Hemorrhage from capillary vessels, called parenchymatous hemorrhage, occurs as an oozing of blood. The steady stream has a color less red than arterial and less purple than venous blood. The escape of the blood into the tissues without having access to the surface through a wound is an extravasation. Extravasated blood which does not become infected is slowly absorbed. It may become a hard mass called hematoma and remain unabsorbed for weeks. A cystic tumor may result from the process.

In certain wounds no blood is visible externally, though a sufficient quantity to cause fatal anaemia may be poured out into the intestines, or abdominal cavity, or into the cellular tissue surrounding the perforated vessel. Such concealed hemorrhages are to be recognized by the constitutional effects produced by the withdrawal of blood from the vascular channels.

The general symptoms of hemorrhage are influenced by the constitutional characteristics of the patient and the vessel from which the blood flows, but depend more especially upon the quantity of the blood lost and the rapidity of its escape. Arterial hemorrhage may be expected to produce greater depression than a similar loss from veins, for the obvious reason that venous blood is, in a certain degree, an effete fluid.

When a violent and profuse gush of blood occurs from rupture of a large arterial trunk, death is rapid. The blood in all the arteries has a recurrent tendency, and, instead of being forced by arterial and cardiac contraction into the peripheral vessels, it flows toward the wound; there may be a consequent venous stagnation which gives a livid tinge to the otherwise pallid surface. The patient, who has fallen to the ground in a state of syncope, gasps for breath, throws his limbs about restlessly, and, after convulsive twitchings of the facial and other muscles, expires. Profuse hemorrhage from a large venous trunk causes death in a somewhat similar manner.

A less impetuous loss of blood, whether arterial or venous, causes a feeble and rapid pulse, sighing respiration, pale conjunctivae and lips, a cold, clammy skin, dilated pupils, restlessness, and a confused mind. The patient feels weak and thirsty, is giddy, has impaired vision and hearing, or, perhaps, sees luminous spots or hears unusual noises, experiences a sense of suffo-

cation, but feels no special pain, and rather suddenly loses consciousness. During this state of syncope the breathing is almost entirely diaphragmatic and the heart's pulsation can scarcely be detected. This lowering of circulatory tension gives an opportunity for coagulation in the wounded vessel, and the bleeding is arrested. The patient now recovers from the condition of insensibility, and perhaps vomits as he returns to consciousness. The increasing force of the heart's action, however, is soon sufficient to cause the blood current to force the clot from the interior of the injured blood vessel, and hemorrhage, with the train of symptoms mentioned above, recurs. This alternation of bleeding and spontaneous arrest is kept up until death occurs from anaemia of the nervous centers. Sometimes delirium, convulsions and hemiplegia precede the fatal termination. In very slow hemorrhage there arises great debility, with waxy looking skin, oedema of the dependent parts, and a tendency to syncope on assuming the erect posture. A blood examination will show the characteristic diminution of erythrocytes and haemoglobin.

After death from prolonged or repeated hemorrhage the tissues are soft and flabby, because the fluids have been absorbed to fill the emptied blood vessels. This explains, also, the thirst felt by the patient. After serious hemorrhage has been stopped a stage of reaction often supervenes, to which the name hemorrhagic fever has been applied. The symptoms are febrile manifestations and a frequent, quick pulse, accompanied by irritability and restlessness of mind and body. Occasionally hemorrhage is followed by a chronic anaemia, which is extremely rebellious to treatment. The febrile state, above mentioned, is to be met by rest, sponging the surface, cold to the head, nutritious fluid food and tonic remedies.

Hemorrhage, from vessels in whose walls a solution of continuity has been produced by accident or operation, often ceases spontaneously. It usually does so in veins, except those of great calibre, and in arteries smaller than the radial and facial. The method employed by Nature in arresting hemorrhage is the same in arteries and veins, though in the latter the sluggish blood current does not demand such active contraction and retraction of the walls of the vessel.

When an artery has been completely divided, Nature promptly

institutes steps which are intended to cause a temporary arrest of the escape of blood until a permanent occlusion of the open extremity can be accomplished. The same series of changes occur in both the cardiac and distal ends of the cut vessel. The temporary means consist of contraction and retraction of the cut end, and clotting of the escaping blood in and around the sheath of the vessel. The permanent means are: The formation of a clot within the artery; plugging of the orifice, and union of the edges of the cut extremity by the ordinary process of repair; and cicatricial contraction of the walls of the vessel by which an impervious fibrous cord is produced.

The contraction of the walls of the vessel, which extends up to the first branch, gives its section a flattened or ovoid shape, and, by diminishing the calibre, lessens the size of the blood stream. At the same time the retraction of the cut end of the artery within the sheath leaves a space between it and the wound in the non-retractile sheath, which detains the escaping blood and encourages coagulation. Coagulation also takes place outside of the wounded sheath. Lacerated vessels, by the irregularities of the torn end and of the sheath, encourage this clotting and, if large, may soon stop bleeding.

These provisions of Nature may at first fail to stanch the bleeding, because the force of the heart is sufficient to drive enough blood through the contracted vessel to wash away the intra- and extra-vascular clots. As the continuing hemorrhage increases the coagulability of the blood and weakens the cardiac power, perhaps to syncope, the time arrives when these temporary expedients of Nature stop the flow. Cardiac strength then returns and may, by the increased intravascular pressure, cause recurrence of the bleeding. In many instances, however, the temporary means are effective until permanent changes can be brought about to repair the vascular traumatism.

When a temporary check has been given to the flow of blood, a coagulum gradually forms within the artery. This is conical in shape, with its base situated and fixed at the opening, while its apex, lying loose in the lumen of the artery, extends as high as the first branch. The base of this internal clot corresponds in size with the interior of the vessel, which it fits like a cork.

After the deposition of this internal coagulum and sometimes

without its formation, for it may occasionally be absent, an exudation occurs in the stump of the artery and around it and the sheath. This plastic material unites the edges of the wound and seals the orifice by a button-like plug of exudate. The internal blood coagulum is at its base more or less intimately associated and commingled with the plastic deposit. Organization of the exudate, disappearance of the blood-clot and permanent cicatricial contraction of the vessel to the first important collateral branch go on, until finally from the first branch above nothing remains but an impervious fibrous cord.

Hemorrhage from a wound partially dividing an artery is controlled in a similar but not identical manner. Contraction and retraction of the vessel cannot occur; but blood is effused within and around the sheath, and thus, unless it rapidly escapes to the exterior of the body, causes pressure upon the wounded artery. This causes temporary arrest of the blood escape. An internal coagulum may then be formed. Lymph is subsequently effused, the cavity of the vessel is occluded and fibrous metamorphosis with obliteration of the vascular channel is permanent. If the wound is less in extent than one-fourth the circumference of the vessel, or if it is longitudinal and consequently gapes very little, hemorrhage may cease and repair occur by plastic exudation, without much encroachment upon the lumen of the vessel. In such cases, however, the internal and middle coats are seldom firmly repaired, and the force of the circulatory current is very apt to eventually cause stretching of these tunics. Thus may arise traumatic aneurism.

When the passage of blood through an artery is arrested by division, ligation or any form of obstruction, the parts beyond receive, at first, less blood. As a consequence, absence of pulsation, lowering surface temperature and impaired muscular power result. Soon, however, the anastomosing branches and capillaries of the same and of the neighboring arteries dilate by a vital process and carry more blood to the part than is normal. This is shown by increased redness and unnatural elevation of temperature, which, in the case of construction of large arteries, only occurs after the lapse of many hours. After a time the duty of supplying the distal region becomes relegated to a few branches, which remain permanently enlarged. The functions of the part

are then carried on exactly as they were previous to interference with the blood-supply.

The establishment of the collateral circulation necessitates a reversal of the blood-current in some vessels, but this is not opposed to physiological processes. The collateral circulation is usually effected by the anastomosis of the branches on the same side of the body and not by inosculation with branches coming from vessels across the median line. Thus, when the right common carotid artery is ligated, the exterior of the head is supplied by the inferior thyroid, a sub-branch of the subclavian, furnishing blood to the ramifications of the superior thyroid, a branch of the external carotid. The current in the superior thyroid is reversed, and the blood emptied into the external carotid, which carries it to the face and scalp. The interior of the head is nourished by the vertebral, a secondary branch of the subclavian, communicating within the skull with the cerebral branches of the internal carotid. Little dilatation occurs in the branches inosculating with the corresponding vessels of the left side.

When a vein is wounded or obstructed, repair and the collateral circulation are effected and established in a similar way. If there is failure in reaching this result, venous congestion and oedema occur in the parts below, and may be the cause of moist gangrene.

So far as general treatment of traumatic hemorrhage in war wounds is concerned, not much need be said. Local arrest in the wound is the immediate duty. It is only after the bleeding vessels have been controlled or when hemorrhage is feared, but has not yet occurred, that general measures obtain much consideration. The patient should be kept quiet and recumbent, with the head low, in order to lessen the activity of the heart and prevent anaemia of the brain. Sudden elevation of the head may be followed by fatal syncope when much blood has previously been lost. The supply of blood to the nerve centers can be kept up, in those who have suffered collapse from profuse hemorrhage, by tilting up the foot of the bed and by encircling the four limbs with rubber bandages, as in the bloodless method of operating. This drives the entire volume of blood to the head and trunk. The elastic pressure can be continued, as we know from experi-

ence in operations, for at least an hour without harm to the extremities thus deprived of blood. This process is called auto-transfusion, because the patient has his own blood forced into the centers of organic life. If several limbs are bandaged, it is well to remove the pressure slowly and from one at a time, lest the sudden rush of blood into the limbs cause recurrent anaemia of the brain. If rubber bandages are not at hand, flannel or muslin bandages may be used; or digital compression of the abdominal aorta and of the subclavian or axillary arteries will prevent the exit of blood to the limbs, and thus leave more for distribution to the head and trunk. The symptoms of shock and hemorrhage are often combined. Reference to this has been made in the chapter discussing surgical shock in war.

Morphine, quinine, ergot, gallic acid, thyroid extract, calcium chloride, lead and iron, in full doses, have been recommended as internal hemostatic remedies, but local treatment is far more important and effective. Hemorrhage renders patients thirsty because it drains out the fluids of the body. Hence water and liquid foods are acceptable and valuable. Perhaps water containing saline ingredients would be preferable to simple water. Tonics, stimulants and concentrated diet should be administered subsequent to profuse hemorrhage, to replenish the loss of the vital fluid.

When death from violent hemorrhage is imminent, transfusion of blood taken from another person who is vigorous and healthy is proper. Venous or arterial blood may be used, and it may be injected into a vein or an artery. Venous blood is generally preferred, because more readily obtainable, and is usually transfused into a vein of the arm. If the blood is transfused from the donor to the recipient without being subjected to manipulation, the operation is direct transfusion. The indirect method consists in drawing the blood into a receptacle, subjecting it to certain chemical or mechanical manipulations and then injecting it into the circulation of the patient.

In performing the indirect operation it is important to keep the blood aseptic, at a temperature of about 100° F., to avoid the injection of portions of clot, and to prevent the entrance of air into the patient's circulation. The quantity of blood transfused should not exceed eight or ten fluid ounces, and should be injected

very slowly. It is not unusual for a marked chill to follow the procedure. The sodium citrate method has taken the place of older methods.

Filling the depleted vessels with a sterile saline solution often seems to be nearly as effectual as transfusion of blood, and is therefore more frequently employed. The solution employed is a 0.6 of a 1 per cent. solution of sodium chloride in water. This is sterilized by boiling, and injected, while at a temperature of 105° F. very slowly into a vein, by means of a fountain syringe and a canula. One formula is this: Sodium chloride 6 parts, sodium carbonate 1 part, distilled water 1,000 parts. To every half liter may be added one drop of a saturated solution of sodium hydrate to render the artificial blood serum alkaline. The amount injected may vary from 1 to 3 pints, depending upon the effect on the pulse.

When the accurately prepared so-called normal saline solution is not at hand, warm water alone or with a little salt in it (about a teaspoonful and a half to the quart) may be used.

If opportunity to make an intravenous injection into the saphenous, median basilic or median cephalic vein is not afforded, the fluid may be forced into the subcutaneous tissue of the thighs or chest. This is accomplished with a hydrostatic bag and a trocar or aspirating needle. When this cannot be done, rectal enemas of water may be employed.

In the resort to local hemastasis the first step is to clean the wound and remove the loose clots. When operating the surgeon should bear in mind that considerable blood may be lost without being realized by him and very serious anaemia may arise. Let him remember also that no artery or vein can bleed if it is compressed by the fingers or a clamp forceps. These facts give assurance that there is always time and means to stop bleeding, at least temporarily. Many arteries that spurt freely when first divided soon cease to bleed. Venous hemorrhage usually requires no treatment except moderate pressure for a few minutes, with pads of gauze dry or moistened with hot water, for, unless from large veins, it ceases spontaneously. Adrenaline solution (1:1000) is a good hemostatic for capillary bleeding.

Elevation of the head has a tendency to check arterial bleeding from head and face, and loosening of tight clothing about the

neck or constricting surgical dressings will often cause venous oozing to cease. Exposure of the bleeding surface to the air or the action of cold water or ice induces contraction of the vessels and diminution of hemorrhage. Laying open a bleeding cavity or removing the warm poultice-like clots from a wound has a tendency to check loss of blood from small arteries and capillaries. Ice may be thrust into bleeding cavities, but its chilling and depressing influence must be watched. Quite hot water is often more satisfactory and better than ice. Adrenaline solution is often serviceable when applied on gauze packing thrust into the wound.

Chemical agents with astringent properties were formerly employed in surgery as blood arresters, under the name of styptics, because of their tendency to promote contraction of the vessels and surrounding tissues and because of their inducing rapid coagulation of the blood. If the hemorrhage is from the veins, capillaries or small arteries, styptics may arrest it, but are needless because pressure by means of compresses or bandages is better. If arteries of any importance are the source of bleeding, styptics are inefficient, and, therefore, worthless. They are objectionable because practitioners resort to them and lose valuable time when ligation, torsion or acupressure is required. Many of them, moreover, by irritating the surface and covering it with pasty clots, or by infecting it with germs prevent union by first intention. Hot water of about 120° F., locally applied, causes blanching of the surface and cessation of hemorrhage. It has the advantage over ice of not depressing the patient. Solutions of adrenaline are very efficacious in arresting capillary bleeding.

All the methods thus far mentioned are greatly inferior to pressure and to occlusion of each individual vessel by ligation, torsion or pressure. When, as in deep cavities without bony walls, it is difficult or impossible to use ligatures or pressure, the cautery iron, heated only to a dull red color, may be employed to seal the vessels by converting the tissues into a dry eschar. In parenchymatous hemorrhage the application of water of not less than 160° F before resorting to cauterization will frequently effect the desired result.

Compression is well adopted. for temporarily arresting hemorrhage until ligation or other operative measures can be performed.

It is also of great value in the permanent arrest of bleeding when there is no vessel of sufficient importance to require ligation or torsion. Direct compression will stop bleeding as long as this pressure is maintained.

A compress and an ordinary bandage, applied evenly and with moderate firmness, will arrest hemorrhage from capillaries, veins and the smaller arteries. A bleeding cavity should be plugged with aseptic gauze or compressed sponge, which may, at times, be held in position with a bandage. No styptic is required, for the pressure causes approximation of the vascular walls, which is followed by internal coagulation, fibrinous exudation, and finally by obliteration of the vessel. In wounds that are expected to heal by first intention the pressure is made upon the integument, after the parts have been properly adjusted.

In using pressure the surgeon must recollect that great force is not required, and that gangrene may result from tight bandaging. The oozing of blood stained serum through the dressings must not be mistaken for a continuance of the hemorrhage. Enough gauze dressing should be applied to prevent the possibility of this serum reaching the surface and becoming septic, between the surgeon's visits. A considerable degree of pressure may be made with impunity, if there is a voluminous gauze dressing over the wound, because the elasticity of the dressing prevents the constriction from coming directly upon the tissues.

When bleeding from a wound is profuse, digital or instrumental pressure should be made upon the main artery, while the surgeon is tying or securing the vessels in the wound. The pressure can then at intervals be relaxed momentarily to allow the bleeding vessels to become distinguishable.

The common carotid artery is controlled by pressure made at the inner border of the sterno-mastoid muscle, on a level with the cricoid cartilage, and directly backward and inward against the cervical vertebrae.

The subclavian artery is controlled by pressure made above the clavicle, at the outside of the sterno-mastoid muscle and directly downward and a little inward, against the first rib. These points of advantage are worthy of recollection in surgical work on the face and neck.

When hemorrhage comes from arteries, whose calibre equals

or exceeds that of the facial or from veins which are so situated that pressure cannot be well applied, each vessel must be separately treated. The methods employed to bring the walls of the artery or the vein into apposition, and thus close the lumen, are ligation and torsion. Acupressure was formerly a good deal employed as a hemostatic measure. Now surgeons are more apt to carry an absorbable suture around the vessel and its neighboring tissues.

Ligation is simply tying an aseptic string tightly around the vascular tube, and thus completely closing its calibre. Ligatures are usually cords of linen, silk or catgut; though wire, tendon, and other materials are occasionally employed. Flat ligatures are, as a rule, not desirable. Absorbable ligatures are usually preferable to non-absorbable ones. Flat ligatures are perhaps used more than formerly in tying large vessels in continuity. Care should be taken not to include an adjacent nerve in the ligature. The accompanying veins and the muscular tissue around an artery are usually separated from it before the ligature is applied; but in smaller arteries it does no harm to include these in the knot. When the knot is tightened, the forefingers or thumb should be placed upon the string close to the artery and firm, steady traction made. The amount of force required to tie even a large artery is not very great, and it should be done without jerking.

The giving away of the inner and middle coats is often distinctly felt by the surgeon. Ligation, as a rule, merely corrugates the inner coats of the veins. Catgut ligatures should be given an additional third tie, because of the liability of the knot when made with catgut to become loosened; or they should be tied in the so-called friction or surgical knot. In this the thread is given two turns instead of one in making the first half of the knot. Ligature should have both ends cut off about one-tenth of an inch from the knot. The "stay knot" of Ballance is a good one for the carotid arteries.

There are five rules to guide the surgeon in the use of ligation for arresting arterial hemorrhage. They are important in head surgery.

I. In cases of primary hemorrhage do not ligate arteries which are not actually bleeding at the time, but have the patient carefully watched.

Reasons for this rule:

1. It is very possible that bleeding has permanently ceased.

2. It is difficult to be sure from which arteries the bleeding came.

3. Manipulations in wounds are to be avoided unless demanded. It increases chance of infection by opening up new channels.

Exceptions to this rule:

1. When a large vessel is plainly seen pulsating in the wound.

2. When the occurrence of even slight secondary hemorrhage would be disastrous, as in a very anaemic patient.

3. When, as in transportation, the patient will necessarily be away from surgical scrutiny. This in military surgery is common.

II. In cases of primary and of secondary hemorrhage the ligature should be applied when practicable in the wound at the point where the artery bleeds, and not in the continuity of the vessel.

It is wise when tying bleeding vessels of the neck and face, unless they be small, to seek both ends of the cut vessel and ligate both. The intimate anastomosis in these regions makes bleeding from the distal end of a divided vessel very likely to occur after the proximal end has been secured.

Reasons for this rule:

1. It is frequently impossible to know which artery is injured until the wound is opened. This is particularly evident in wounds of the floor of the mouth.

2. Secondary hemorrhage may occur, even after ligation in continuity, from the establishment of the collateral circulation. This secondary bleeding may come even from the proximal end of the cut vessel, if a branch of considerable size is given off between the wound and the point of ligation.

3. Ligation in continuity makes a second wound, and adds the possible complication of this wound to the patient's original dangers.

4. Ligation in continuity remains, as a reserve step, still possible, if ligation in the wound fails.

Exceptions to this rule: None.

III. If the artery is completely severed both ends should be

tied; if it is partly divided or punctured, a ligature should be applied to the vessel on each side of such wound.

Reasons for this rule:

The collateral circulation will probably cause secondary hemorrhage from the distal portion of the vessel, unless double ligation be adopted.

Exception to this rule:

When the distal end cannot be found, then pressure must be made in its neighborhood.

IV If a large artery is wounded near its origin, tie it below the wound, and tie the trunk from which it arises both above and below the point of origin of the branch. If a trunk is wounded near the origin of a large branch, tie the trunk with two ligatures in the ordinary manner, and apply a third ligature to the branch.

Reasons for this rule:

The force of a large current of blood near the internal coagulum may lead to its displacement, and cause secondary hemorrhage when the ligature is absorbed or causes ulceration of the external coat.

Exception to this rule: None.

V. When it is impossible or impracticable to tie the vessel in the wound, ligation in continuity may be permitted for primary bleeding.

Pressure or torsion with clamp forceps, acupressure and compression of bleeding vessels with a suture through adjacent tissues are rapid means of stopping bleeding when no assistant is at hand to ligate. These expedients are efficient as temporary stayers of blood flow. They may be depended upon for a permanent arrest in the small vessels of a wound. Acupressure or compression with a suture is also useful as a preliminary step when an operator expects to divide several branches of a supplying vessel. Thus, the facial arteries at the lower margin of the mandible may be temporarily occluded by a suture carried through the skin, around the artery and tied before a proposed flap from the cheek is cut. So in extensive plastic operations on the face and neck it may be wise to expose the external or the common carotid trunk and lightly compress it with a rubber-covered spring clamp during the operation. The pressure should be rather wide and

not so great as to break the internal coats of the artery. At the conclusion of the operative procedure the current in the artery is restored by removing the pressure; and the branches which bleed are tied as usual in the wound before it is closed.

When it is difficult to apply ligatures or acupressure in deep wounds, the hemostatic forceps may be used to seize the artery and close the wound, and then be allowed to remain so attached as clamps for one or two days. If aseptic they do no harm, except to make dressing of the wound a little inconvenient.

The prevention of secondary hemorrhage is to be secured by obtaining rapid union in wounds. Hence aseptic healing is important. In war surgery secondary hemorrhage has been quite frequent even with the improvements of recent years in early aid and antiseptic dressings. Military casualties, especially in oral injury, are very liable to become infected.

When secondary bleeding is feared the patient should be kept absolutely quiet, and undue circulatory activity controlled by aconite, low diet, and laxatives. Morphia and similar drugs internally in full doses are beneficial under some circumstances. So also is partial compression of the main arterial trunk supplying the injured region, and elevation of the head or limb in which bleeding is feared. The patient should be kept in secondary face hemorrhage in the semi-recumbent or even in the erect position.

In dealing with secondary hemorrhage the surgeon must not delay. In primary hemorrhage it is injudicious to take active steps when bleeding has already ceased, unless the circumstances are exceptional. The case is different in secondary bleeding. The first escape of blood, even in small quantity, calls for action, which may, it is true, be limited to elevation of the part and compression of the wound and main artery by compresses and bandages; but the second actual outbreak of hemorrhage imperatively calls for prompt surgical measures. If healing of the wound is still quite incomplete, the sutures should be withdrawn, the clots turned out and the vessel from which bleeding has come securely ligated. As it may be somewhat difficult to determine the exact source, every suspicious point should be ligated. If the softened or sloughing condition of the wound surfaces prevents satisfactory application of ligatures, pressure or the actual cautery may be available

Opening the wound is the proper procedure even if union is well advanced, for the escaping blood has usually distended the wound cavity before the existence of bleeding has been detected; and by his action, moreover, the surgeon obtains the most accurate information possible of the character of the complication with which he has to deal. Acupressure is often a valuable means of arresting the bleeding either before or after the wound is reopened. By thrusting the pin deeply through the tissues and reinforcing the pressure with a strong thread wrapped around the ends, the surgeon is enabled to compress parts in which one or more bleeding arteries are situated. This maneuver may be employed to avert the necessity of laying open the partially cicatrized wound, or to secure vessels whose patulous mouths cannot be found on the surface of the wound because of spontaneous cessation of bleeding.

Instead of an acupressure pin a strong ligature may be carried through the tissues by means of a long needle; by tying the ends of this cord together constriction may be effected that will restrain hemorrhage, but it must not be sufficiently great to cause strangulation and gangrene.

If the facial or lingual seems to be difficult to secure because of the condition of the wound, the external carotid is to be exposed to view and tied. The anatomical relations of this vessel must be recollected. To tie the internal carotid would be a serious error. The external carotid lies near the internal carotid, but is nearer the median line of the neck than the internal carotid. It is internal in position, but is called external carotid because it supplies the external surface of the head.

When secondary hemorrhage persists despite the direct treatment applied at the seat of trouble, it is proper to ligate the main artery in continuity, as is done in dealing with aneurisms. Such ligation should be performed as near the seat of hemorrhage as possible unless the anatomical relations of the regions make it known that the arterial anastomosis will soon establish such a collateral circulation that hemorrhage will probably recur in the original locality. Then it becomes necessary to select a higher point for the deligation.

Secondary hemorrhage may supervene after an arterial trunk has been tied in its continuity for the arrest of hemorrhage at a

more distal point. Here the first step is to apply pressure to the seat of ligation by a graduated compress or by plugging the wound. If this fails the wound must be opened and a ligature applied at each side of the orifice in the vessel, which must then be completely divided between the ligatures, if the original injury did not do so, in order to allow retraction and contraction of its walls. In the event of this being followed by recurrence of hemorrhage, a second deligation in continuity at a point nearer the heart, with or without contemporaneous ligation of one or more anastomosing branches, is proper.

Bleeding from the large veins of the neck may embarrass the surgeon in dealing with extensive wounds from shell and shrapnel in the face. The dangers from wounded veins are hemorrhage, septicaemia, diffuse phlebitis, fat embolism, and entrance of air into the heart.

The bleeding from the jugular trunks may be as fatal as arterial hemorrhage, but that from small veins usually stops spontaneously unless there is some source of constriction upon the cardiac side of the wound. Blood flows from wounded veins in a darke rapid stream without showing the pulsatile action of the heart; it has, however, an increase in its force during each act of expiration, if the seat of hemorrhage is near the trunk. Pressure made on the cardiac side of the wound causes an increased flow of blood. This may be of diagnostic value in deep wounds in the neck; blood from arteries may be dark during anaesthesia or when the bleeding comes the distal end of a divided artery in one of the extremities.

Subcutaneous rupture of a vein from violence may occur. The extravasation of blood, even if large, is usually absorbed in a few days or weeks; but it may cause inflammation leading to abscess, if pyogenic bacteria gain access to it, or become encysted in a fluid state, giving rise to a fluctuating tumor called hematoma.

Incisions and punctures of veins, when not fatal, usually heal rapidly and perfectly by first intention, leaving no scar and not encroaching on the calibre of the vessel. Slight pressure for a few seconds stops venous bleeding from small vessels, unless there is constriction on the cardiac side of the wound. The large veins like the internal jugular need lateral ligature, or suture

with fine silk or catgut, or circumferential ligation both above and below the laceration or incision.

Septicaemia is very apt to follow venous wounds, if the open vein or sinus is surrounded by infective fluids; hence asepsis is of supreme importance in treating wounds in which large veins are opened. Ligation by closing the open orifices tends to prevent such septic infection, and is, therefore, at times advisable in major operations, when sepsis cannot be prevented, even when there is no liability to venous hemorrhage. Fat embolism may occur through wounds of veins.

If from any cause the wound in a vein is kept widely open during violent inspiratory efforts, air may be sucked into the venous circulation and be carried to the right heart. This accident is especially liable to occur during operations in the vicinity of the internal jugular, subclavian, innominate and axillary veins; though it has been stated that it may happen in veins of smaller calibre and in those situated further from the heart. The manner in which wounded veins ordinarily become collapsed during inspiration usually prevents the entrance of air; hence it is only when some cause holds the lips of the wound apart that sucking air into the veins is possible. This may be due to inflammatory thickening of the walls converting the vein into a tube, the so-called canalization of the veins; to the vessel being imbedded in hardened tissue or in the substance of tumors, which prevents collapse; or to the efforts of the operator, who, in attempting to enucleate a tumor or foreign body, pulls the walls of the vein apart at the time of a deep inspiration. The accident is less common since the introduction of anaesthesia, because there are less struggling and gasping on the part of the patient and more deliberation exercised by the surgeon. It is possible, however, that some of the deaths attributed to anaesthesia may be cases of air in the veins.

The symptoms of entrance of air into the veins are marked. During the progress of an operation in the neck a sudden sucking sound may be heard; frothy blood is, perhaps, observed in the wound, the pulse fails, the heart beats irregularly and feebly, respiration is oppressed, and syncope or, perhaps, convulsion occurs. If the amount of air drawn in is small, recovery gradually takes place; if the quantity is considerable, coma and death

may supervene. The fatal issue may be immediate, but usually is postponed for a period varying from a few minutes to an hour. In cases that recover transitory paresis has been observed. Secondary pneumonia has proved fatal in others. Occasionally a sound similar to that poduced by air entering the veins occurs when the deep fascia of the neck is incised.

The pathology of the symptoms induced by air in the veins is not understood. It is probable that the air, causing a frothy condition of the blood in the right auricle and ventricle, prevents proper action of the valves and interferes with the blood transfer in the pulmonary circulation. Anaemia of the brain and other nerve centers is thus induced.

This serious complication of operative surgery, which is surely quite rare, is to be prevented by securing regular and quiet respiration during anaesthesia, by tearing the tissues in the vicinity of large veins apart with fingers, forceps, scissors and dull instruments, instead of using the knife, and by avoiding any posture or traction that tends to keep venous wounds gaping. When it becomes necessary to divide a large vein the surgeon should make pressure with the fingers upon the vessel at the cardiac side of the proposed wound. This should be done also when firmly attached pieces of metal or broken bone are being forcibly enucleated.

When air has actually been sucked into the veins, prompt treatment is demanded. The vein should immediately be compressed at the cardiac side of the wound, and ligatures should then be applied on both sides of the orifice. The patient's head should be lowered, stimulants should be given, and artificial respiration instituted.

Galvanism of the chest and cardiac region, transfusion of saline solution, tracheotomy, venesection and pumping air from the veins or even from the heart, by the aspirator, have been proposed. The injection of warm water directly into the heart cavity has been suggested. If the symptoms depend upon failure of the valve action because of absence of fluid in the heart, this may perhaps be a rational therapeutic measure.

It is probable that the dangers of air in the veins and heart have been overestimated. It has been suggested that some cases of death supposed, from post-mortem examination, to have been

due to air embolism may have been the result of infection with the bacillus aerogenes capsulatus. This organism causes a rapid development of gas in the tissues.

Septic phlebitis in connection with operative or accidental wounds of the face is of serious import. The venous channels of the head are not so well supplied with valves as are veins of the extremities. Septic emboli are, therefore, more readily carried to other parts of the circulation. Septic meningitis and general septicaemia are easily induced and are very potent arguments for antiseptic technic in face surgery incidental to warfare.

CHAPTER VIII.

LIGATION IN CONTINUITY OF THE LARGE ARTERIES OF NECK AND FACE.

When exposing an artery for ligation the surgeon must first of all determine the exact course of the artery by the well-known landmarks of clinical anatomy and the linear guides which are based upon its anatomical relations. If the artery is superficial its pulsation will aid in this determination. If a muscle such as the sterno-mastoid is one of the guides, it can be made to stand out prominently by getting the patient, before etherization, to use it voluntarily. The line of the tendon or artery may then be marked on the skin with the scratch of a needle or knife point.

The second step is to decide upon the point of ligation. In secondary hemorrhage from deep gunshot wound or knife thrust it is best, if practicable, to expose and tie the vessel near the wound and on both sides of it. The ligature should be applied not less than one-half an inch from the origin of any large branch or bifurcation of the artery. When this is anatomically impossible it is often wise to secure the branch also with a ligature to prevent secondary hemorrhage, which otherwise may result from the forcible collateral current developed in the branch or bifurcation.

A double curve incision like the letter S may be made slightly oblique to the course of the artery and with its center over the point chosen for ligation. When the artery is deeply located, whether from its anatomical relations or the obesity of the patient, a long incision is demanded. There is sometimes an advantage in raising an elliptical flap of skin and subcutaneous tissue like a trap-door, instead of making a straight cut, because a better opportunity is thus given for recognizing the landmarks. Large superficial veins should be drawn aside, if convenient, though their division with ligation is of little importance. The deep fascia is to be incised in a similar manner as the skin, or it may be punctured and a grooved director slipped under it; after which maneuver it is divided by carrying the inverted knife along the groove. The original length of the incision should be maintained until the sheath of the artery is reached. If the deep

fascia is so tense as to prevent satisfactory investigation of the parts beneath, a short incision may be made across the middle of the longitudinal one.

The carotid arteries, with the accompanying internal jugular vein, are enclosed in a distinct fibrous sheath. This sheath is to be opened by pinching up a fold with small toothed forceps and making in it with the knife a cut about three-quarters of an inch long. While the forceps holds the edge of the opening, the end of the grooved director or aneurism needle is introduced into the sheath on each side of the artery and used to break up the adhesions between the vessel and the sheath or the adjacent contents of the sheath. Isolation of smaller arteries which have no distinct sheath can be readily performed by using two pairs of forceps to pull away the small veins and cellular tissue.

It is well to remember the characteristics of an artery in the living subject. It has a pinkish white, smooth, shining surface and is compressible, feeling as it is rolled under the finger-tips as if two surfaces were slipping upon each other. A large nerve has not this smooth, shining surface, but has longitudinal markings, due to its fibrous structure, and rolls under the fingers as a solid, non-compressible cord. A vein is purplish, soft and flaccid, and from its distention with dark blood resembles a leech in appearance. It becomes more distended when pressure is made on its cardiac end. A small tendon is pearly white and glistening and gives, when seized, the impression of great density. The recognition of a small artery is often aided by its location between two satellite veins and by its pulsation. Pulsation, however, may be absent, because exposure and manipulation sometimes cause arteries to contract and become temporarily pulseless. On the other hand, a deceptive pulsation may be transmitted to nerves or fascial bands lying over an artery.

After the artery has been recognized and isolated, the end of the curved aneurism needle, threaded with antiseptic catgut or silk, is carefully passed around it without disturbing its surroundings or pulling it from its bed. As the carotid has a single vein alongside of it, the needle should be introduced at the venous side of the artery, because puncture of the thin wall of the internal jugular vein on its deep side by the end of the aneurism needle is thus avoided.

If by mishap the internal jugular vein is wounded during an attempt to tie the carotid artery, it may be wise to lengthen the incision in the overlying structures. After closing the gap in the vein by suture or lateral ligature, the operator should apply the ligature to the artery at a point nearer the heart than that at which the vein has been secured. The surgeon should compress the artery between a finger and the loop of the ligature before he actually ties the knot, in order to be sure that the pulsation of the vessel beyond will really be stopped by constriction of the structures about to be ligated. This will confirm the belief that he has the desired blood vessel within the loop of his catgut or tendinous thread. He might be about to tie the internal instead of the external carotid artery, or have the pneumogastric nerve encircled instead of the artery. The tie should be made with a surgical or friction knot or a flat knot; when catgut is employed it is always well to make a third tie and leave the ends rather long, because catgut has a tendency to untwist itself. The stay knot, recommended by Charles Ballance, is a reliable one.

During the tying, the index fingers should be kept down in the depth of the wound, so as not to pull the vessel up from its bed. Just enough tension should be made to insure division of the inner and middle coats of the artery. This will be recognized by a feeling of the wall giving way as the noose is closed by the surgeon's fingers. It will probably be wise usually in military surgery to tie the carotid arteries in two places about three-quarters of an inch apart and cut the vessels midway across between them. This in case of delay in healing of the wound makes less likely the occurrence of secondary hemorrhage from the anastomosing current, should the operation wound become the seat of septic processes.

LIGATION OF THE COMMON CAROTID ARTERY.

The direction of the common carotid and its continuation, the internal carotid artery, corresponds with a line drawn from the sterno-clavicular point to the tragus of the ear. The common carotid artery extends only to the level of the top of the larynx, where it bifurcates into the external and internal carotid arteries. The left carotid has its origin lower than the sterno-clavicular articulation, but in this intrathoracic portion of the

artery surgeons have little interest. This circumstance, however, renders ligation of the carotid below the omo-hyoid muscle safer on the left than on the right side; because the ligature is further from the blood stream in the parent vessel. The external carotid at its origin lies from a quarter to a half inch *nearer* the middle line of the neck than the line given for the internal carotid. The surgical relations are shown in the chapters on Anatomy.

The common carotid artery lies beneath the anterior edge of the sterno-mastoid muscle in a sheath, which also encloses the internal jugular vein and the pneumogastric nerve. The vein lies on the outer side of the artery, the nerve lies behind both and in the groove between them. The descending branch of the hypoglossal nerve forms a loop with branches from the cervical plexus, usually upon the front of, but sometimes within, the sheath. The artery becomes more and more superficial as it ascends. Its sheath is crossed by the omo-hyoid muscle about midway between the sterno-clavicular joint and the top of the larnyx; or, in other words, at the level of the cricoid cartilage.

For ligation of the common carotid, the patient's head should be thrown well back, with the chin turned toward the opposite side. A small pillow or roll of cloth under the nape of the neck enables the surgeon to keep the patient in this posture. A sigmoid incision or a flaplike trapdoor two and a half or three inches in length, with its center corresponding to the level of the cricoid cartilage, should be made along the anterior edge of the sternomastoid muscle. When the fascia and the platysma-myoid muscle have been divided and the fibers of the sterno-mastoid become visible by the dissection, the margin of the latter muscle must be turned outward and the angle between it and the omo-hyoid muscle, with its obliquely ascending fibers, found. If the omo-hyoid is pulled inward and the sterno-mastoid outward, the sheath of the artery, with very possibly the descending branch of the hypoglossal nerve upon it, will be seen. The sheath will also be recognized by its slipping sideways between the finger and the vertebrae behind, and by the pulsating vessel within it. The external and anterior jugular veins should be drawn aside, if in the line of the dissection. When this cannot be done, they may be tied and divided. The sheath is then

opened toward the tracheal side of the artery, which is isolated with care, and the needle passed from without inward, in order to avoid injury to the internal jugular vein lying on the outer side of the artery. This operation ties the common carotid artery just above the omo-hyoid muscle, which is the better situation for application of a ligature.

To ligate below the omo-hyoid, make a three-inch long incision just in front of the anterior margin of the lower third of the sterno-mastoid muscle. Detach the inner portion of the muscle from the clavicle and turn it outward. The omo-hyoid and the sterno-hyoid muscles will thus be exposed. These are to be pulled apart with hooks, when between and below them will be seen bulging upward the sterno-thyroid muscle. The finger thrust down between the lower part of the omo-hyoid and the sterno-thyroid, which is on a lower plane, will feel the artery beating in its sheath.

It may be necessary to incise the sterno-thyroid in order to expose fully the sheath, which is then opened and the aneurism needle passed around the artery from without inward. In both operations the branch of the hypoglossal nerve should be protected from injury as much as possible.

LIGATION OF THE INTERNAL AND EXTERNAL CAROTID ARTERIES.

The common carotid artery should not be tied for a lesion of the external carotid or its branches, when there is room between the bifurcation of the common trunk and the lesion to allow the safe application of a ligature to the external carotid. Ligation of the external carotid alone should be performed in many conditions which formerly were treated by tying the common carotid trunk. On the other hand, ligation of the internal carotid artery may be performed in some intracranial lesions instead of tying the common carotid and interfering with the current in both the internal and external carotid arteries.

For ligating the internal carotid, a sigmoid incision or a trap-door flap two and a half inches long, with its center about half an inch above the upper border of the larynx, should be made a little oblique to a line drawn from the sterno-clavicular joint to the tragus of the ear. The vessel will be found along the edge

of the sterno-mastoid muscle. The hypoglossal nerve crosses the vessel about an inch above its origin, and the descending branch of the same nerve will probably be found running down the artery. The hypoglossal nerve and the digastric muscle, which also crosses the artery, should be drawn upward and the ligature passed from without inward, avoiding constriction of the internal jugular vein and the pneumogastric nerve on the outer side, the external carotid on the inner side and the hypoglossal nerve superficially.

The external carotid artery, which also is crossed by the hypoglossal nerve and digastric muscle, may be tied by a similar incision, but it must be remembered that this artery is situated a little nearer the middle line of the neck than the internal carotid artery. If a large branch is given off near the point of ligation it also should be tied.

The lingual, external maxillary (facial), and thyroid arteries will very occasionally require ligation in continuity. Their relations are shown in the chapters on Surgical Anatomy.

CHAPTER IX.

ANAESTHESIA.

General anaesthesia may be induced by oro-nasal inhalation or by insufflation through a tube, the end of which is placed within the naso-pharynx, the mouth, the larynx or the trachea. General anaesthesia has been induced by an intravenous method, also by insufflation through the rectal route; and analgesia by oral medication; but resort to these modifications is infrequent. Selection of the agent and the choice of the method depend somewhat upon the location of the operative field, the surgical requirements of the condition, and the varying organic integrity of patients.

Of the four anaesthetic agents usually employed for induction of general abolition of pain, nitrous oxide gas is probably the safest and chloroform the most dangerous. Sulphuric ether holds the place next to nitrous oxide for safety and ethyl chloride approaches chloroform in its relatively dangerous character.

The chief disadvantages of nitrous oxide are the requirement of bulky containers and special apparatus for its administration, and that it is not a good anaesthetic for protracted operations unless combined with inhalation of oxygen. This increases the bulk, expense, and complication of the inhalation outfit. Short operations can be performed without pain under the primary anaesthetic effect of ether, or under local anaesthesia, just as well as under general anaesthesia from nitrous oxide. Nitrous oxide does not secure as satisfactory a relaxation of muscles as does ether inhalation. It is probable that nitrous oxide is a safer anaesthetic agent in those who are subjects of diabetes mellitus and nephritis than ether, but it is not considered safe in patients with marked cardiovascular disease or in those suffering from obstruction of the air passages.

The safety, convenience and simplicity of ether anaesthesia has made it the most generally adopted form for operative surgery. In the hands of even an inexperienced anaesthetist it has a wide range of safety, while under the control of an expert, who is careful, attentive and alert, gives scarcely any risk to life and very little danger even to those patients who have organic

disease of heart, lungs or kidneys. Ether vapor is very inflammable and it should not be employed as an anaesthetic agent when an open flame or the actual cautery is to be near the patient's head. Should it become desirable or necessary to use it under such circumstances, the source of light should be placed high above the etherizing couch and no fire should be near or below the operating table. Ether vapor is heavier than air and falls toward the floor. It may, therefore, be ignited from a stove, open fireplace, or candle placed at a lower level than the etherizing towel, or when there is exposed artificial light in a small room.

It is my opinion that general narcosis from ether and either local or conductive anaesthesia, induced by one of the various drugs now available, fulfill all reasonable requirements for obtaining analgesia, anaesthesia, and muscular relaxation in operative surgery. Resort to other agents may under exceptional circumstances be desirable or wise.

Nitrous oxide gas with associated oxygen inhalation is a very valuable second choice, but it has the limitations mentioned above. As a preliminary inhalation before the application of the ether towel to the nose and mouth, nitrous oxide affords a means of avoiding the disagreeable odor and pungent effect of the ether felt by the patient. This gas-ether sequence has therefore an advantage in children and nervous patients.

Before etherizing a patient the surgeon should examine the kidneys, heart and lungs. The presence of disease in one or all of these organs should not deter him from the administration of ether, when necessary for a painful operation; but the knowledge of its existence will render him exceedingly cautious. Anaesthesia should be avoided, if possible, during an attack of bronchitis, and when the kidneys are not secreting a normal amount of urine. A few days' delay will permit these conditions to be remedied by treatment. Anaesthesia is always a dangerous condition, and requires the undivided attention of an experienced assistant. Death has occurred not infrequently from etherization and often from chloroform anaesthesia.

The patient's stomach should be empty, lest vomiting occur during and after anaesthesia. Hence, he should fast for four or six hours prior to etherization, and it is even better if no solid

food has been taken since the previous day. A hypodermic injection of morphia (gr. $\frac{1}{6}$ to gr. $\frac{1}{4}$) and atropia (gr. 1/120 to gr. 1/100) should be administered to adults about thirty minutes before inhalation is begun. This renders anaesthesia quieter, more rapid and safer. It is not an essential adjuvant to anaesthesia, but it limits laryngeal irritation, lessens accumulation of mucus in the air passages, prevents to a great extent post-operative nausea and vomiting, and continues the freedom from pain after recovery from the anaesthetic unconsciousness. An additional hypodermic injection of hyoscine hydrobromide (gr. 1/50), given just before the ether inhalation is started, will permit the surgeon to perform a long operation with a minimum quantity of ether. I believe this adds to the safety of the general narcosis by lessening the amount of ether to be eliminated by the patient subsequent to the anaesthetic sleep. It is an indubitable fact that many operators permit the anaesthetist to soak the patient's tissues with an unnecessary amount of ether vapor. This preanaesthetic hypodermic dose of hyoscine gives the patient, I think, a slight cyanotic tinge, but I have never recognized any evil due to it or the preliminary hypodermatic use of morphin and atropia.

All clothing restricting deep inspiration must be removed or loosened prior to beginning inhalation of gas or ether. False teeth and pieces of tobacco or chewing gum must be removed from the mouth, because of the danger of their falling backward into the fauces and obstructing respiration. The patient is placed in the recumbent position. In operations upon the nose and palate it is often better to have the patient lying on his back with the head so bent backward that the palate is lower than the floor of the mouth. Blood is then kept away from the site of operation and flows down the œsophagus and not into the larynx. Choking and coughing are thus avoided. When these preliminaries have been arranged, the patient is shown how to inspire and expire deeply, and is encouraged to do so for a few moments. It is well to teach him to breathe properly by placing the gauze towel or handkerchief over the face for a few seconds before adding ether. It is not necessary to anoint the lips and cheeks, nor to spray the nose and throat with cocaine, before inhalation. These steps are sometimes advocated.

No inhalation apparatus is required. A cone of paper containing a loosely folded towel is a very satisfactory contrivance; but a small piece of sterile gauze or a clean handkerchief loosely folded and covered by a large towel so that the ether vapor cannot escape is usually preferable. The outer towel should cover the eyes of the patient, and no loud talking on the part of the bystanders should be allowed until insensibility occurs. The senses of sight and hearing should not be stimulated by any such disturbing influences. Quiet encouraging words spoken by the anaesthetist, however, are valuable aids to deep breathing and rapid unconsciousness. The ether vapor should be given in a concentrated form; from one to two fluid drachms should be poured on the gauze at first, that renewal may not often be required. When inhalation has once fairly begun, the ether cloth should not be removed from the face, unless spasm of respiration or actual vomiting necessitates its temporary withdrawal. It should not be removed from the face while additional doses of ether are being poured upon it; but the corner of the outer towel should be raised and the anaesthetic poured on the gauze in sufficient quantity.

If the room is kept quiet, the patient previously given the morphine and atropine and taught how to breathe deeply, a full amount of ether poured on the towel, the eyes of the patient covered, and no air admitted to the lungs except that which passes through the gauze and towel, complete anaesthesia can be obtained in from five to ten minutes in nearly every instance. *It is not safe to give chloroform or ethyl bromide in this manner.*

During the entire period of etherization the administrator must carefully watch the respiration, color of skin, and pulse. The first two points demand especial scrutiny, but the changes in cardiac force, which can be most conveniently investigated at the temporal artery in front of the ear, must not escape examination.

It occasionally happens that after a few inhalations have been taken a spasm of respiration takes place, evinced by absence of inspiratory effort and cyanosis of the face. This calls for the withdrawal of the ether for a moment; soon a deep inspiration occurs, and no further symptoms of asphyxia are shown. If in the stage of excitation the patient struggles and cries out, the

ether cloth must be kept closely applied, because access of air increases the excitement. Retching as if vomiting were about to occur is an indication to keep up the ether. Vomiting does not take place during complete anaesthesia. If, however, the stomach contents are regurgitated upward into the pharynx and mouth, the etherization must be stopped until the fauces are cleared of materials that might pass into the larynx. The suspension of inhalation should be as momentary as possible. Sometimes the ether vapor causes an abundant secretion of bronchial mucus, which collects in the larynx and fauces and causes impeded respiration. This is especially seen when the atropine and morphine have been omitted. This complication is met by clearing the throat with a finger introduced into the mouth, or by turning the patient on his face for a moment with his head hanging down over the edge of the operating table.

When muscular relaxation is complete, and a tendency to snoring noticeable, the time for operation has arrived. The ether may then be withdrawn or only administered in sufficient quantities to keep up the anaesthetic state without inducing a continuance of loud palatal and laryngeal stertor. Stertorous respiration usually means that anaesthesia should not be pushed, since the patient is then insensible to pain. Patients are often given more ether after insensibility is profound, and are kept more deeply under the influence of the drug than is requisite. This is reprehensible, for it throws more work on the kidneys and lungs, by which the ether is eliminated, than is justified. A full dose at the start and comparatively small doses afterwards fulfill the requirements.

It will be seen by this description that I have little use for the so-called drop method of giving ether. With preliminary use of morphia and atropia the method I have described is efficient, safe and prompt. The so-called "drop method" in the hands of many administrators of ether is a delusion and a snare. Quantities of ether are wasted by being poured on the outside of a thick pad of gauze and much unnecessary delay occurs from the method with no commensurate advantage to the patient.

There is a primary anaesthesia of etherization lasting about a minute, which is associated with muscular relaxation and occurs soon after inhalation has begun. This stage of etherization may

be utilized for the performance of such operations as opening abscesses and extracting teeth. The recovery from this anaesthetic condition is very prompt and unattended with the nausea and other after-effects of prolonged etherization. This primary anaesthesia or first insensibility of ether is not sufficient for other than minor surgical operations. It resembles the analgesic effects of rapid respiration more than true anaesthesia. It answers for reduction of fractures and luxations.

When patients regain consciousness after etherization they occasionally become very noisy and hysterical. The shouting can be stopped by pouring a little water into the mouth every time the patient opens it to cry out. This compels him to close his mouth to swallow.

If dangerous symptoms, such as asphyxia or cardiac failure, occur during the administration of an anaesthetic, the inhalation must at once be suspended. If mucus or vomited matters produce interference with respiration, they must be promptly removed. Tracheotomy might be demanded when ankylosis of the jaws or other causes interfere with proper clearance of the larynx. Imperfect respiration may be due to an effect of the ether on the nerve-centers. Pulling the tip of the tongue forward with forceps or pushing the lower jaw forwards, with the fingers placed behind its angle, often aids the respiratory function; but artificial respiration and electrical stimulus may occasionally be required. In many cases dashing cold water in the face, slapping the cheeks with a towel dipped in water, or pouring a little ether upon the epigastrium is sufficient. These devices are seldom if ever needed except under an ignorant or careless etherizer.

The simultaneous inhalation of ether vapor and oxygen gas seems to lessen the danger of the anaesthetic state. It is easily accomplished by passing oxygen from the iron bottles, in which it is furnished under pressure, through a wash bottle containing ether instead of water. It then passes, mixed with the ether vapor so obtained, through a tube to an inhaler held over the nose and mouth of the patient. The ruddy color of the patient and the quick recovery from the anaesthetic state make this method of inducing anaesthesia seem very satisfactory. Geoffrey Marshall, who investigated the subject in the British service in France, says that in such injuries as require amputation of an

extremity in shocked soldiers, nitrous oxide gas and oxygen are so much safer than any other anaesthestic that no other agent is justifiable.

Pneumonia has occasionally been observed after etherization. It is not certain how this complication arises. It has been attributed to infectious material, inhaled from the nose and throat or from the etherizing apparatus, and to improper exposure of the patient to drafts after leaving the warm operating room.

Heart failure producing anaemia of the brain is combated by inversion of the body, perfect muscular quiescence, and inhalations of nitrite of amyl. In addition atropia, digitalis and perhaps ammonia should be given hypodermatically in full doses to combat the toxic effects of ether. Experimental investigation in physiological laboratories seems to prove that alcohol is injudicious in the treatment of ether poisoning. It should, therefore, not be given in such cases. If this experimental evidence is accepted, it is also improper to administer alcohol before etherization to avert shock. Quinine, atropia, digitalis, and morphia are preferable.

Persons addicted to alcoholic stimulation require more ether to induce profound anaesthesia than temperate ones, because they have become habituated to the effects of similar intoxicating agents. The administration of the anaesthetic must be cautious, because the viscera of drunkards are frequently diseased.

It is unwise to etherize a patient without assistance, because dangerous symptoms might arise from the anaesthetic or the operation, and the surgeon alone would be unable to give efficient aid. A woman should never be etherized by a man unless a third person is present, since a charge of criminal assault might be made because of erotic dreams during the anaesthetic state.

For operations upon the mouth, nose or throat, it is convenient, after inducing anaesthesia in the manner just described, to keep up the narcosis by forcing the vapor of ether through a metal tube placed in the commissure of the mouth or through two tubes pushed through the nostrils to the pharynx. The mouth or nasal tubes are connected with a long rubber tube coming from the top of a bottle about half full of ether. In this ether is submerged the open end of a glass tube connected by means of a rubber tube with a hand or foot bellows. The etherizer blows

air through the ether by means of the bellows, and thus sends ether-charged air into the lungs of the patient by the nasal or oral route. This simple apparatus enables the operator to work without being obstructed in his manipulations by the etherizing towel covering the mouth and nose. It is seldom necessary to place the ether reservoir in a warm water bath though this is done by some operators. The occurrence of coughing and swallowing on the part of the patient during the early stages of ether inhalation, suggests that the vapor is being given in a too concentrated dose. Such swallowing efforts in the late periods of anaesthesia are an indication that there is likely to be vomiting, or a return to consciousness. Should the anaesthetist meet with these symptoms, he ought, in the former instance, to give the patient less ether and more air; in the latter, more ether vapor should be administered, unless the operator wishes discontinuance of the anaesthetic sleep. If actual vomiting take place, care must be taken to suspend anaesthesia until the fauces and mouth are completely cleared of the vomited materials. Otherwise vomitus may enter the larynx or trachea, and perhaps cause asphyxia or secondary inspiration pneumonitis. The siphon method of withdrawing mucus and blood, used by dentists, is often of value in operations on the mouth and nose under anaesthesia. It lessens the necessity for frequent mopping of the mouth and pharynx.

Intratracheal insufflation of ether vapor suggested by Meltzer and Auer is valuable in operation upon the thorax, during which collapse of the lung is liable to occur. It has value also in oral and pharyngeal operations by permitting the anaesthetizer to keep his apparatus away from the operative field and makes asphyxia from inspiration of blood, mucus or vomitus, readily preventable. It requires a silk or rubber catheter to be slipped through the glottis into the trachea down almost to its bifurcation. This is done after the patient has been etherized by one of the usual methods. Through this tube, ether vapor is blown into the lungs.

INTRA-TRACHEAL ANAESTHESIA.

The seriousness of gunshot wounds of the oral, mandibular and other structures of the face and pharynx at times makes it

desirable to use intratracheal anaesthesia instead of the simpler methods. In this method a soft rubber catheter is introduced through the glottis and slowly pushed into the trachea. Ether vapor mixed with a varying amount of air is pumped with a bellows through the catheter into the larynx. There must be room alongside of the catheter for an airway out during expiration. The apparatus is somewhat complicated, but the method is valuable in the surgical treatment of face and jaw injuries; especially when readjustment of fractures and the overlying soft parts is undertaken at a very early moment after the receipt of injury. The intratracheal anaesthesia apparatus requires experience in its use, but it will probably be found in most of the military hospitals. It ought not to be difficult to attain the necessary deftness for introducing the catheter in war practice where there are so many opportunities for cadaver practice.

The apparatus consists of a vaporizer with appropriate tubes and valves, an ether chamber with gauge, a rubber catheter to be introduced into the trachea through the larynx and a dental bellows. A hot-water jacket, the necessary tubing to make connections, a mouth gag and tongue forceps complete the outfit. In addition, to facilitate the introduction of the catheter, an introducer into which the catheter is threaded may be included.

As a primary step, the patient is etherized in the ordinary way with towel or mask over the nose and mouth. The ether chamber partly filled is suspended in the water jacket above the level of the water which should have a temperature of about 95° F A sterilized catheter, properly oiled, is introduced by the anaesthetist, either with or without the special metal instrument for making the introduction more simple. It should be of a size not greater than half the diameter of the lumen of the trachea, namely, about 24° F. During the introduction, a gag holds the patient's mouth moderately open and an assistant steadies the head in the median line in normal extension. The anaesthetist steadies the tongue by holding its tip, and with his right hand or the forceps exerts moderate traction. With his left forefinger he feels for the epiglottis, passes the finger over it and draws the epiglottis and tongue forward. The catheter is then introduced behind the epiglottis and is slipped into the larynx very much as the similar operation is done in intubation for edema of the

glottis or laryngeal diphtheria. The catheter should be gently pushed down for a depth of about 8 cm., after which the introducer, if it has been used as a guide, is withdrawn and the catheter slowly thrust downwards to about 22 cm. from the front teeth. The patient should be quite deeply etherized during the placing of the catheter. If no introducing implement is at hand, it is not very difficult to put the catheter in place, particularly if an assistant grasps the larynx with thumb and fingers and elevates it during the manipulations within the pharynx.

After the catheter has been put properly in place, the vaporizing outfit is connected with its outer end. The anaesthetic state is continued by means of regular respiratory movements of the patient. The ether tension should be increased with the bellows from time to time until the proper proportions of air and ether vapor are reached which will continue the anaesthetic state required. The outer portion of the catheter may be fastened to the upper lip or cheek with adhesive plaster, in order to prevent its displacement during the operation. Warning is given that anaesthesia by the intratracheal method should not be started until the anaesthetist has fully satisfied himself that the catheter has really entered the glottis and has passed through the larynx into the trachea. This is proved by finger touch within the mouth. It is necessary at all times to keep a continuous current of pure air, or air charged with ether vapor, passing through the tube and there must be a clear airway for expiration from the lungs. Nasal tubes may be introduced to maintain the airway out if the operative procedures leave the nasal passages free.

If the pharynx is to be packed for the purpose of staunching blood or any other reason, it is absolutely necessary that an expiratory current is given exit. After the operation has proceeded to a point where anaesthesia is no longer required, pure air may be pumped through the catheter until the patient recovers sensibility. This will be shown by the return of reflex movements of the pharynx. The condition of the patient gives information as to whether the percentage of ether vapor in the air pumped into the lungs should be increased or lessened. The temperature of the room, the temperature of the water in the jacket beneath the ether chamber, and the rapidity of pumping determine the percentage. It is regulated by the valve which

gives the anaesthetist control of the proportion of ether vapor to air admitted.

Appliances to regulate the pressure and to warm and moisten the air, charged with ether, are connected with a foot or hand bellows or an electric fan, by means of which the air and ether vapor are insufflated into the lungs of the patient.

Geoffrey Marshall says that intrathecal administration of stovaine is dangerous when used as an anaesthetic for the recently wounded. In many cases its use is followed by a great fall of blood pressure and symptoms of cerebral anaemia, such as pallor, vomiting, loss of consciousness and perhaps convulsions. The syncope is sometimes fatal. An analysis of 50 consecutive operations has shown, in Marshall's opinion, that it is the man, who has lost blood and whose wounds are less than 40 hours old, for whom spinal anaesthesia with stovaine is dangerous. The patients had wounds of lower extremities, and the hemoglobin percentage was recorded before operation. The records seem to show that a low hemoglobin percentage is not followed by collapse after a late intraspinal anaesthesia with stovaine; but it is very apt to have such a formidable sequel when used early, say within 40 hours of injury, should a low hemoglobin percentage show that the blood had been diluted by hemorrhage.

Intrathecal stovaine anaesthesia produced a collapse in shocked patients which neither strychnine nor pituitrin were able to combat; nor did preliminary injection of strychnine prevent this collapse. The most satisfactory preventative was to have the head of the patient low and the feet high. This posture may be given the patient with safety, he says, by waiting fifteen minutes after the stovaine lumbar injection.

Marshall further states that a man suffering shock from a recently shattered limb which must be amputated is a very unfavorable subject for general anaesthesia. He advocates, for a reduction of mortality, rest in bed and hot bottles or a hot-air bath. He says morphine should be given only in small doses or withheld. I am rather inclined to doubt the justice of this statement about morphine except in the hands of the careless anaesthetizer in throat and mouth cases. Then there is danger, perhaps, of inhalation of septic fluids, because the laryngeal reflex is

lessened by morphine. He prefers nitrous oxide gas and oxygen to all other anaesthetic inhalants.

His statements are that with chloroform the man's condition will deteriorate and he will not rally; that with ether by inhalation the patient's condition may improve and blood pressure rise during operation, but collapse will occur within two hours. Intravenous use of ether may be followed by a more striking temporary improvement, but the subsequent collapse will be deeper and the fatal result more frequent.

LOCAL ANAESTHESIA AND NERVE BLOCKING OR CONDUCTIVE ANAESTHESIA.

For trivial operations, such as opening abscesses, removing small tumors, incising the chest for emphysema, local anaesthesia is sufficient. It is induced in one or two minutes by applying a lump of ice sprinkled with table salt, or a mixture of ice and salt, to the skin; by blowing ethyl chloride or other refrigerating vapor upon the surface with an atomizer, or by employing cocain or novocain upon, or under, the surface.

Local anaesthesia obtained by the use of aqueous solution of hydrochloride of cocain is eminently satisfactory. A 2 or 4 per cent. solution of this salt in water painted upon a mucous membrane with a camel's-hair pencil or dropped upon it from a medicine dropper will produce local anaesthesia in about three minutes.

Many wounded men have been exposed to cold and wet and are suffering from respiratory catarrh before injury. These inflammations may be aggravated after wounding by prolonged delay in being recovered from No-man's land, additional exposure from lying in mud and water, or from the occurrence of snow or rain storms.

Ether especially is liable to set up active bronchitis or bronchopneumonia in these patients, if administered as an anaesthetic. Shipway's apparatus for warming the ether vapor has proved, according to Bowlby, of great value.

Cranial injuries of even major importance may be readily operated upon without pain with local anaesthesia. Infiltration of novocain and adrenaline in a circle or rectangle around the area of operation is sufficient. Preliminary hypodermatic injec-

tion of morphin and hyocine an hour earlier will aid in preventing pain.

As has been said, local use on the surface of cocain will permit the performance of any minor operation without pain. If the application first made does not produce anaesthesia in the part to which it is applied, repeated applications may be made in a similar manner. The anaesthesia thus produced lasts a number of minutes.

The poisonous nature of cocain and its destruction by boiling to make its solutions sterile have made it less satisfactory as a local anaesthetic than eucain hydrochlorid and novocain. Both of these similar drugs are much less toxic and can be subjected to boiling in solution without losing their local anaesthetic value.

For cutaneous operations it is necessary to inject the cocain or novocain into or under the skin with a hypodermic syringe. The infiltration method of using cocain, advocated by Schleich, is the best means of anaesthetizing the skin. The hypodermic needle is thrust into the skin, not through it; and the solution is forced into the interstices of the corium. Numerous punctures are thus made, and the site of operation becomes oedematous by reason of the fluid. The white wheals, made by the pressure of fluid displacing the blood, are evidence that the anaesthetic solution has been properly distributed. The first puncture may be made at a point made insensible by freezing. Subsequent punctures are made in tissue already anaesthetized. Various strengths of solution are employed by Schleich, but they are all weak. A good formula is: Cocain hydrochlorid, gr. jss; morphine hydrochlorate, gr. $\frac{1}{3}$; sodium chloride, gr. iij; water, ℥iij ʒiij. Not over eight or ten fluid drachms of this should be injected. The solution for local anaesthesia may be incarcerated in the part into which it has been injected by checking the venous return from the infiltrated area by means of a ligature or a rubber ring. If an operation is to be made upon a finger or upon the penis, for example, the anaesthetic will last longer and prove more effective, if it is incarcerated at the seat of operation, by tying a piece of tape, or placing a rubber band, around the base of the member, before the hypodermic injection. A mucous surface to be rendered anaesthetic by cocain applications should not be alkaline, else the anaesthetic power of the drug will not be

exerted. The soap used for cleansing should be washed off with sterile water to avert alkalinity due to any remaining soap.

It must be remembered that death has occurred from poisoning by cocain used as a local anaesthetic. It is best, therefore, to avoid the toxic effect by using, as a rule, for mucous membranes a solution no stronger than 2 to 4 per cent. It is seldom wise to use more than twenty minims at the most, unless the drug has been incarcerated. Then, after operating, the surgeon can by intermittent relaxation of the band allow it to enter the system gradually, or the drug may be washed out of the tissues by allowing the blood to flow from the wound immediately after the incision. For injection into the tissues, five-tenths of 1 per cent. is about as strong a solution of cocain as seems wise. It is probably better as a rule to avoid the use of cocain when prolonged or major operations about the face or other parts are to be attempted under local anaesthesia. Novocain has become a much more satisfactory drug for this purpose, and is used quite freely with safety in a quarter or one-half per cent. solution, in sterile water or salt solution, up to 100 or more cubic centimetres.

Major operations, such as excision of the maxilla, thyroidectomy, and amputations of the limbs, are possible under local anaesthesia or nerve blocking, with novocain solutions.

The addition of adrenalin chlorid solution (1 :1000) to the local anaesthetic solution increases its anaesthetic effect by constricting the blood vessels and thus lessening the blood content of the part. Its actoin limits absorption, lessens bleeding, and extends the period of painlessness. No more than fifteen minims of adrenalin solution of the strength just given should be contained in any dose of the anaesthetic solution employed at an operation. This modification may be employed in infiltration anaesthesia and also in superficial application of the novocain solution to mucous membrances.

Quinia and urea hydrochlorid solutions of one-quarter to 1 per cent. are used for local anaesthesia, in which prolonged freedom from post-operative pain is desired.

The indirect method of procuring insensibility to pain is called regional or conductive or nerve blocking anaesthesia. In this procedure, the novocain is infiltrated into the overlying struc-

tures before making incisions for uncovering the nerve trunks supplying the region. The benumbing drug is then injected into the sensory nerves or the tissues immediately surrounding them, The sensory nerves supplying the part to be subjected to operation become anaesthetized. This gives a regional anaesthesia over the distribution of the peripheral nerve branches.
part. Its action limits absorption, lessens bleeding, and extends

The anoci-association of Crile consists of a combination of general and local anaesthesia. The former prevents the psychic impressions caused by pain; the latter blocks the sensory nerve paths, thus stopping painful afferent impulses and consequent efferent reflex movements.

Profound narcosis is therefore unnecessary, because while the patient is under moderate general anaesthesia the local anaesthetic is injected into the sensory nerve trunks supplying the operative region to benumb them; and infiltration anaesthesia of the tissues involved renders the local loss of sensation complete. By this combined abeyance of physical and mental impressions pain, fear and reflex motions are reduced to a minimum or abolished. As a result, operative and post-operative pain, and soreness and consecutive disturbances, are practically or entirely absent.

Nitrous oxide and oxygen may be employed for the general anaesthetic; quinine and urea hydrochlorate, novocain or cocain for the local agent. Other anaesthetic agents are available.

CHAPTER X.

COMBUSTION WOUNDS AND FROSTBITES OF THE FACE. WOUNDS DUE TO ELECTRIC CURRENTS.

COMBUSTION WOUNDS.

The use of liquid fire in modern warfare and frequent contacts with explosive projectiles give rise to wounds from burning. Uncomplicated burns are unattended by bleeding; but they require reparative metabolic action for cure, open the way for infection of the injured tissues, and are essentially wounds. At the time of the receipt of a burn or combustion wound the skin is usually sterilized by the heat. The consequent inflammatory reaction, however, causes an ingress of serous exudate to the irritated region. This lifts the epidermis from the skin and causes blisters, should the heat be sufficiently severe or long enough applied to cause more than a temporary erythema.

Should the epidermis which has been detached from the derma, forming blisters, in burns of moderate severity, be rubbed off by rough handling of the patient, the moist surface of the true skin is exposed. This becoming wet with albuminous transudate, affords a perfect culture medium for microbic growth and for absorption of bacterial products.

When the skin alone, or the underlying structures, soft or bony, have their cells destroyed, the dead tissue must be separated from subjacent and adjacent living structures by the usual line of demarcation. The area beneath and around the slough, unless kept dry, becomes an atrium of entrance for microorganisms. Thus suppuration and septicaemia are frequent secondary effects of deep burns, unless the surgeon succeeds in keeping the burned skin absolutely dry or sterilized. Local ulceration remains when the slough is separated after the occurrence of pyogenic infection; and the resulting cicatrization causes, through contraction of fibrous tissue, great displacement and distortion. These deformities alter the superficial and deep relations of skin, muscle, joints and bones.

When the caloric dermatitis has been set up by hot liquids, instead of by flame or by contact with hot solid objects, the

burning is called a scald. Here initial dryness of the wound is impossible, and a desiccating treatment difficult. Inflammation of the skin resulting from long exposure to the sun's rays, or from the frequent or prolonged application of x-rays in fluoroscopic or radiographic examinations, is often called a burn. There is a resemblance to the pathologic condition found after heat contacts, because in each instance a dermatitis is set up; but the exciting cause is so different that the term "burn" should not be used. So also should injuries from sunlight and

Fig. 61.— Multiple centers of cicatrization after burn of head, resembling centers from skin-grafting, due to varying depth of skin destruction in a combustion wound.

from the chemical effects of strong acids and alkalies upon the cells of the skin be excluded from the category of burns.

Diminution of the effect of the sun's rays by covering the surface of the body with dark clothing or shadow producing protectives prevents sunburn. Interposing lead plates, rubber, or other non-penetrable objects in a similar manner between the Crookes's tube and the body obviates danger from x-ray "burns." These agencies of skin irritation as well as chemical irritants,

however, are foreign to the present discussion, though the principles of treatment of the resulting dermatitis may be like those involved in handling burns from high temperatures. Contact with live electric wires occurs in war because defenses are not infrequently charged with high voltage currents. The local effect of such artificial lightning is similar to what happens in thunder storms from electric shock. They also are rather improperly classed as " burns." The resulting effect upon the skin may, however, produce superficial or deep inflammation, infection and ulceration. Electric burns may occur from short circuits occurring while handling electric light wires and from " blowing out " of fuses by short circuits.

In addition to the local effect of heat, there occur general symptoms due to extensive burns which are of great importance when large areas of skin are exposed to contact with high temperatures. These seldom occur, however, in burns of the face.

It is the pain and the interference with cutaneous excretion in large superficial burns which induces shock, albuminuria, suppression of urine, acidosis, nephritis and at times death. Deeper injuries over a limited surface may be less serious in their consequences. Ulcer of the duodenum or stomach, long known as a sequel of burns, is probably the result of a septic process, perhaps embolic in nature. The lesion occurs from septic conditions in abdominal and pelvic surgery as well as from burns of the skin. The so-called surgical scarlatina appears to be more common after burns than other wounds of the surface. Infection with the bacterial cause of scarlatina doubtless may arise through cutaneous breaks in the skin; but some cases of surgical scarlet fever are probably septic dermatic lesions.

A pathological classification divides burns into three classes: Erythematous burns; those so superficial in their injurious influence that only hyperaemia and a slight serous transudate into the skin occur. Vesicating burns, in which a greater amount of cellular damage is caused, and, as a result, vesicles, or even great bullae, are produced by an effusion of serum, blood or sero-lymph between the derm and the epiderm. Necrotic burns, which destroy the upper layers of the true skin, its whole thickness, and even the underlying soft tissues and bone, are a third variety. The third kind of burns is therefore followed by eschars. The

detachment of these sloughs of dead cells, if the killing process has gone much below than the skin, leave deep ulceration which is repaired by fibrous tissue. The occurrence of infection and slow healing gives this fibrous tissue a better opportunity to exert a disastrous contractile force. Hence come eversion of eyelids and of lips, adhesions of auricles to cheek, occlusion of nares, distortions of head on the neck and chest, and even deformity of the infant or adolescent mandible, which is dragged out of its normal relation to the other structures of the face.

In erythematous burns the skin is red, painful, and swollen; but these inflammatory symptoms subside in a few hours or days, and no cicatrix is left, even when disquamation takes place.

Vesicating burns promptly show vesicles or blebs filled with clear or blood-stained serum, and are the seat of active inflammation causing severe pain. The serum escapes by rupture of the vesicle or is absorbed, and a new epidermis is formed in the course of a week. If the old cuticle is early cast off or removed by friction, so that the cutis is exposed to irritation and to infection from pyogenic germs, in the air or on the clothing, great pain and superficial suppuration result. No cicatrix follows vesicating burns, though a discolored stain, similar to that seen after blistering with cantharides, may remain for a time.

Necrotic burns destroy the vitality of the tissues; therefore the eschars, when separated, leave ulcerated surfaces to heal by granulation. The pain of such burns is intense, if shock does not prevent its being felt. The dirty brown color of such burns is characteristic, but it is impossible to tell how deep the destruction has been until the sloughs separate. If the parts are kept aseptic there will be no suppuration under the eschars, which will drop off when the parts are healed. Otherwise cicatricial contraction and deformity are usually great. The cicatrices may assume a very rough and irregular appearance from abnormal development of fibrous tissue. Keloid and malignant degenerations at times attack such scars. Exposure to x-rays causes "burns" which, if chronic, seem especially likely to become cancerous.

When burns are severe enough to cause constitutional manifestations, these symptoms are exhibited in three stages: 1, that of shock; 2, that of inflammatory fever; 3, that of exhaustion.

The stage of shock is accompanied by feeble, frequent pulse, great depression of the nervous system, lowered temperature, chills, nausea, restlessness and perhaps delirium. Pain is not very prominent, if shock is great. Greater shock attends burns of the trunk than of the face or limbs. Congestion of the brain, of the thoracic and of the abdominal organs occurs, and the patient may die in twelve or twenty-four hours without showing any reaction from the collapsed state. The degree of shock caused in children and the aged is greater than that in the middle period of life.

Fig. 62.— Occlusion of nose, eversion of lips, and distortion of eyelids due to sloughing from burn. (*Author's patient.*)

Fig. 63.— Same as figure 62, after several operations. Further operative treatment needed.

The stage of fever, which lasts from the second to about the fourteenth day, is characterized by increased bodily temperature, disordered secretions, great thirst, and often by inflammation of the internal organs, such as cerebral meningitis, bronchitis, pleuro-pneumonia, nephritis and enteritis. It is due largely, if not entirely, to infection of the burned surfaces. Ulceration of the duodenum, sometimes proceeding to perforation, is a remarkable lesion occurring at times during this stage. It is to be

suspected if hypogastric pain, vomiting of blood, abdominal tenderness, and bloody stools are observed. Its occurrence has been attributed to the unusual vicarious action thrown upon the duodenal glands. and also to a possible embolic plugging of the vessels of the intestine. Duodenal ulcer, if it occurs, is developed, as a rule, about the seventh or tenth day of the inflammatory stage. In this stage albuminuria varying with the temperature

FIG. 64.— Cicatricial eversion of lower lip and dragging down of mandible so that mouth cannot be closed, following necrotic burn. (*Author's patient.*)

and a small vesicular eruption thickly scattered over the trunk, have been noticed.

The stage of exhaustion is due to the depression, caused by the inflammatory irritation, and by the profuse suppuration often accompanying the detachment of the eschars and the cicatrization of the resulting ulcers. Infection usually occurs before the surgeon reaches the burned patient. There is great debility but

no pain unless the ulcers are subjected to pressure or rudely handled in reapplying dressings. Amyloid visceral changes may possibly result from prolonged suppuration. Erysipelas and tetanus occur at times from infection.

Inflammatory oedema of the glottis from inhalation of steam may be a cause of death; but flame itself is not inhaled, as is supposed by the laity. In most instances where incinerated bodies

Fig. 65.— Flexion of head from sloughing after burns treated by incision and long flaps from back brought around neck like a collar. (*Author's patient.*)

are found in burned buildings, asphyxia has occurred from the gaseous products of combustion before the tissues have been subjected to the action of fire. Spontaneous combustion of the human body is impossible.

The constitutional treatment of burns should be directed to the relief of shock and pain, the prevention of secondary visceral inflammations and the support of the general powers of the system; while topical remedies should be employed to relieve pain, moderate local inflammation, prevent infection, hasten cicatrization, and prevent contractile deformity.

Reaction from shock should be sought for by the application of heat and the administration of stimulants and concentrated food in small quantities. The hot bath (100° F.) may be available to raise temperature and relieve pain. The addition of sodium bicarbonate to the bath might be beneficial. Pain is to be relieved in severe cases by an immediate hypodermic injection of a quarter or half grain of morphia, or by the inhalation of an anaesthetic. Anaesthesia is often desirable before attempts are

Fig. 66.— Ectropion of lower lip after severe burn. Greatly improved by flaps from back.
(*Dr. Joseph M. Spellissy's patient.*)

made to remove clothing; morphia will then be effective in prolonging the freedom from pain. In the later stages of burns, laxatives, diuretics, revulsives and other antiphlogistic measures may be demanded to prevent internal inflammation and to substitute the derivative action of the skin. The stage of exhaustion pre-eminently requires tonics; and on this account actively depressing remedies are to be avoided in the inflammatory stage.

The local treatment varies with the degree of burn. Erythematous burns, if limited in extent, are relieved of pain by solu-

tion of sodium bicarbonate, a saturated solution of picric acid, lead water and laudanum, and in fact by almost any dressing that excludes air and constringes the dilated capillaries. A household remedy for small burns of this degree is to hold the part near a hot fire and thus apply dry heat. Zinc oxide or stearate powder, or wheat flour, dusted over the burned surface is useful.

The proper treatment for vesicating burns is to puncture aseptically the blebs carefully and allow the serum to escape, so as to prevent the epidermis being rudely rubbed off. This epidermis makes the best possible protection from irritation and septic infection. Antiseptic cotton or some form of dry sterilized dressing may then be applied. A working rule in severe burns may be prompt anaesthesia with chloroform, carefully given, or nitrous oxide gas; then a full hypodermatic injection of morphia with a little atropia. After the patient is thus relieved of pain, the clothing may be carefully removed, the burned surfaces cleansed with a mild non-toxic antiseptic solution, then dried and covered with sterile cotton. Cotton adheres less than gauze to the injured surface when one removes it later.

The dressing should not be changed oftener than once in two or three days, because detachment of loosened cuticle and exposure to air increase pain, and germ infection is likely to occur. Powders are probably better than ointments and prevent septic contamination better. Boric and salicylic acids are harmless, or practically so. Much harm is often done by tearing off the epidermis when removing underclothing.

Necrotic burns require the same line of treatment as vesicating burns, with which, indeed, they are usually associated. Continuous immersion in a hot bath (100° F.) is a very valuable line of treatment. Blair recommends a pack of alcohol, or of 5 per cent. solution of collidal silver to render the edges of the eschars aseptic during the time the line of demarcation is likely to become infected. After separation of the sloughs the ulcers are to be treated as previously described. Metallic astringents are often exceedingly valuable to keep down redundant granulations and hasten repair of the breach of continuity. Skin-grafting, in its numerous forms, is often required, and lessens contraction of the cicatrix. It should be done early to hasten epidermization and preclude the great contraction of fibroid scars.

When possible burned surfaces should at once be rendered aseptic by thorough cleansing and disinfection with antiseptic solutions. To do this anaesthesia and scrubbing the burned surface with soap and a brush may be justifiable if the patient's condition does not contra-indicate. Deaths occurring after the period of reaction are largely due to sepsis.

Much attention of late has been given to covering burned surfaces with an antiseptic protective dressing of paraffin. The paraffin, which is rendered antiseptic with betanaphthol or other

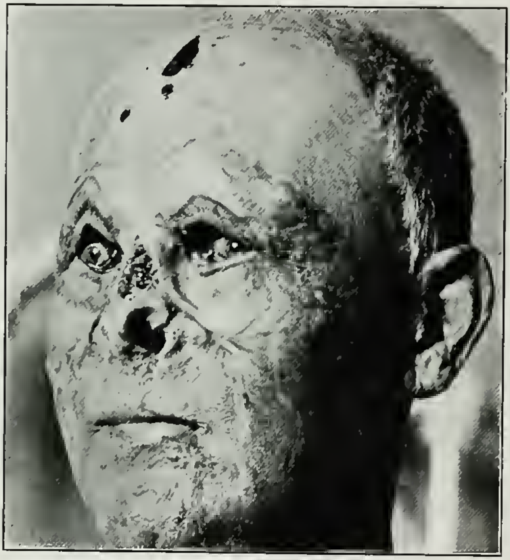


FIG. 67.—Multiple facial distortion from necrotic burns. (*Author's patient.*)

non-toxic antiseptic, should have a melting point of about 50° C. The combination made liquid by heat is then applied as a thin film over the burned or scalded parts by means of a brush or an atomizer. If the injured area has previously been made aseptic, the paraffin coating prevents infection and need not be very frequently removed. The surface should be previously cleansed and dried by alcohol followed by acetone. Over the film of liquefied paraffin wax, should be placed a thin layer of cotton wool saturated with the hot wax. A bandage is applied after the

wax has hardened. Such a dressing protects the exposed nerve filaments from irritation, thus relieving pain; and can be renewed from time to time without causing by its removal the torturing pain so distressing to patient and attendant under the older forms of treatment. The complicated recipes for the paraffin dressing are said to be an unnecessary adjuvant. Plain paraffin of the appropriate melting point to make it practicable is said to be as efficacious as the vaunted combinations. The urgent attributes appear to be a relatively sterile burned surface, an easily applied solidifying liquid, and infrequent dressings with a material that will not become attached to the raw or granulating surfaces on which are exposed sensitive nerve fibrils.

Submitting the uncovered burned surfaces to open air and to the continuous glare and heat of electric lamps has been a fairly acceptable local treatment of severe injuries due to heat. The patient's naked limb or body is kept night and day under a canopy, made of hoops, covered with a sheet within which the electric lamps are placed. Stearate of zinc powder may be dusted over the burns. The heat will soon dry the secretions from the blistered areas, but later, crusts form. If these scabs are not removed rather frequently, serum and pus are retained, causing some maceration of the surface. This is undesirable. For burns of the face, the electric light treatment would not be wise because of the effect of the strong illumination on the eyes. It is probable that in these burns the open air and paraffin treatment will prove satisfactory without using the electric light. It may be applied as suggested by Lee and Furness, who place over the burn-wound a single layer of sterilized mosquito netting which has been previously dipped in hot liquefied paraffin wax in such a manner as not to fill the interstices of the net when the paraffin cools. The rubber netting suggested by Davis to hold skin shavings in place after grafting probably would be equally efficient. The discharges from the burned surface, exuding through the netting, dry in the open air and cause scabs. As the paraffined fibers do not usually stick to the wound or granulations, lifting the net by its edges permits the crust to be removed almost painlessly. If the netting does stick, spraying with paraffin oil loosens it. The air treatment is by these authorities made antiseptic by spraying a 1 per cent. or 2 per cent. solution

of di-chloramine T first on the wound and later through the meshes of the netting. Other efficient antiseptics may be used in this way.

It seems as if this method would be very applicable to face burns; which naturally one would desire to have exposed to the air to avoid bundling up the head with bandages. Face wounds, if kept dry and aseptic, heal very rapidly. The greatest ingenuity has to be called into play in the endeavor to prevent cicatricial contraction, which is especially marked when a deep burn has injured the surface of the face. The scar contraction everts the margins of eyelids or lips, narrows the outlets of normal canals, flexes or extends joints and renders them immovable, drags features out of position causing horrid deformity, and binds neighboring structures together into one mass. During cicatrization this contraction should be prevented as much as possible by early skin grafting, or by transferring or transplanting flaps to cover the granulating surfaces.

Wounds from chemical agents will be decreased in severity by promptly neutralizing the injurious agent and then treating the so-called burns as one would a burn from heat or an ulcer from other causes. Acids should be neutralized with alkalies, such as solution of sodium bicarbonate and tooth powders; strong alkalies by vinegar or any mild acid; carbolic acid by alcohol or whisky.

X-ray dermatitis and ulceration require management similar to inflammation from other irritants. The chronic ulcers may need to be dissected out and the resulting wound to be grafted.

FROSTBITE.

Frostbite of the external nose, the auricles, the prominences of the cheek, or the chin, is liable to occur in campaigns during winter weather. If the exposure of the surface of the face to intense cold is sufficiently prolonged, inflammation occurs, giving rise to the injury called frostbite. Chilblain is a local palsy and dilatation of the capillary vessels of the skin caused by a previous slight freezing or by repeated frostbite. Its symptoms are a bluish-red swelling accompanied by itching, burning and tenderness, which may be followed by blistering and even ulceration. Chilblains are most common in those of feeble constitution and

are likely to reappear in previously frostbitten parts, when the weather changes from cold to warm. The intolerable itching is characteristic. Frostbites resemble burns, except that their course is slow; like burns, they are of three degrees of severity: erythematous, vesicular, necrotic.

Erythematous frostbite follows exposure to a moderate degree of cold, and is due to the capillary congestion and slight inflammatory serous effusion that succeed the primary contraction of the vessels. The skin during the application of the low temperature becomes white from deficient circulation, wrinkled and numb; but as soon as return to warmth occurs, a bluish-redness, swelling and tingling pain or itching arises. The equilibrium of circulation is restored gradually and no further pathological changes occur.

When the cold is greater or more prolonged the parts become white, entirely insensible and shrunken, and reaction is accompanied by inflammation leading to vesication. The vesicles of vesicating frostbite are usually filled with blood-stained serum, and there is danger of gangrene occurring from the violence of the inflammatory process.

Extreme cold devitalizes the tissues at once and they have a mottled appearance from coagulation of blood in the superficial vessels. The necrosed structures are finally separated in the same manner as sloughs produced by heat or chemical agents. In these cases of necrotic frostbite, as well as in vesicating frostbite leading to gangrene because of active inflammation, it is impossible to tell how much of the tissues is capable of having physiological function restored. Amputation, therefore, must not be attempted in the primary condition of the injury.

The extremities and the peripheral points, such as the ears, nose and chin, fingers, toes and penis, are most frequently frozen in military campaigns, because normal circulation is less active in these localities. For a similar reason persons with weak hearts, and those enfeebled by disease, dissipation, or old age, are most liable to suffer from exposure to low temperature. Cold combined with moisture or wind is more dangerous than cold and dry weather without wind.

The treatment of all degrees of frostbite should begin by preventing sudden return to normal temperature, because sudden

access of blood to the injured capillaries will cause pain and a high degree of inflammation. Hence the parts should never be subjected to heat or put in warm water. The circulation and sensibility are to be restored gradually by friction with articles only a little warmer than the frozen parts. Snow, ice water and wet cloths are usually employed for this purpose. Afterward slightly stimulating applications, such as alcohol, perhaps tincture of iodine, may be used to complete the reaction. Friction toward the trunk may be valuable because the venous return is thus assisted and congestion in the semi-paralyzed capillaries rendered less intense.

The erythematous, vesicular and necrotic inflammations that occur after reaction has been established are to be treated very much as burns of similar degrees. Anodyne and cooling lotions or ointments, evacuation of the serum in the vesicles, and protection of the skin from atmospheric contact and infection are indicated. The resulting ulcers are managed as such without regard to their causation. Amputation is frequently required after severe frostbite, but should not be done until the line of demarcation has been definitely formed. Parts that are insensitive when a needle is thrust into them at the time of freezing will often have the circulation restored, much to the surprise of the surgeon.

The treatment of chilblains is very unsatisfactory. Tincture of iodine; carbolic acid (1:10); carbolized ointment of petroleum; menthol; tincture of cantharides; tincture of aconite root; camphor liniment; chloroform; metallic astringents and chloral, as lotions or unguents, and similar applications, are to be tried. Tincture of iodine (mxx), ether (fʒii), collodion (f℥i), may be applied with a brush. Perhaps hypodermic injections of fluid extract of ergot (mx) or of ergotine (gr. iij) near the seat of pain would be beneficial. The ulcers that occur demand treatment calculated to cause healing and to alleviate the itching pain.

The chief interest of frostbites in facial surgery is that the surgeon may be called upon to restore by plastic operation the tip of the nose or chin or a part of the auricle. Flaps from the cheek are obtainable in the lines of the respective naso-labial furrows to construct a portion of the nose which has sloughed from frostbite. The helix or lobe of the ear may be repaired with

satisfaction with pedicled flaps from behind and below the external ear. The chin is reparable with a flap from below the mandible.

FACIAL WOUNDS DUE TO ELECTRICAL CURRENTS.

Electrical burns of the face and neck may occur in war from entanglement in live wire defenses, and from accidental contact when fuses are burned out by short circuits. After the patient has recovered from the general symptoms of electric shock, the inflammation, ulcers and deformities arising from such contacts are to be treated as other burns.

The passage through the animal body of a strong electrical current on its way to the earth produces the same effects, whether it be lightning or an artificial current from a "live" wire. Alternating currents are more dangerous than continuous currents. The patient may be killed instantly, or, after a period of apparent death, may recover. During the period of unconsciousness the respiration may not be apparent and the pulse may be imperceptible. The symptoms may resemble those of laceration of the brain, namely, insensibility, slow and labored respiration, weak and irregular pulse and dilated pupils. Burns of the surface may be produced, especially where the current entered the body and where it emerged. Laceration of the soft tissues and injury of the bones may occur. The disorganization of the blood and its extravasation from the vessels may cause marks upon the surface having a branching or tree-like form. Money, keys or buttons in or upon the clothes of the patient may be fused by the current and be deposited as a thin metallic film on portions of the skin. When a rapid recovery does not occur, neurasthenia, partial paralysis, blindness or insanity may ensue. The burns may be followed by gangrene and heal very slowly.

The bystanders should remove the patient from contact with the "live" wire, if he be still touching it, or shut off the current by the proper method of breaking the conducting wire. Care must be taken that the current does not pass from the injured person who is still in the circuit through the person who attempts to aid him. The rescuer should put on rubber gloves before touching the patient, catch a portion of his clothing without touching his skin, or wrap his own hands up in a dry cloth and

break the circuit by then lifting the patient by means of his clothing from the earth or wire. It is sometimes possible to slip a dry cloth between the patient and the ground and thus break the circuit and make it safe to touch him while still in contact with the live wire and earth. Another method of rescue is to push away the wire with a dry stick, or cut it with a pair of scissors with dry wooden handles. Wet clothing greatly increases the danger of conduction. These precautions are unnecessary when the shock has occurred from lightning directly or by the induced current due to an adjacent object being struck by lightning. Persons struck by lightning or shocked from a live wire should be treated for a long time, even if apparently dead, since recovery has taken place after several hours of apparent death. Artificial respiration is very valuable; surface stimulation by friction or mustard plasters and hot-water bottles may be useful. Hot rectal enemas may do good. It is said that the internal use of alcohol as a stimulant is undesirable. Strychnia may be used. The burns may cause extensive sloughing and the resulting ulcer be very long in healing. The local and general symptoms should be treated on accepted surgical principles.

CHAPTER XI.

GUNSHOT AND OTHER FRACTURES OF THE FACIAL BONES.

Gunshot fractures in the face are usually perforating and therefore very liable to involve the cavities of nose, mouth, ear, sinuses or pharynx. Comminution and infection are common com-

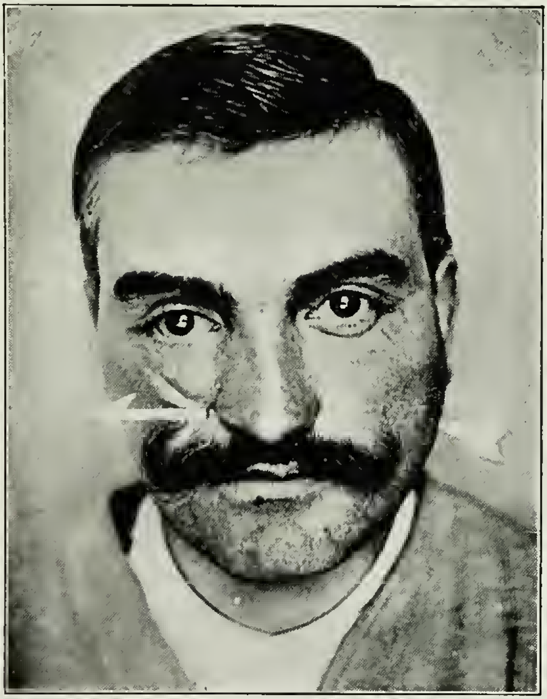


FIG. 68.— Perforating bullet wound causing fracture of bones of face. (*Courtesy of Dr. H. W. Scarlett.*)

plications. Secondary hemorrhage is a likely sequence of such infection unless foreign bodies are early removed and the track excised, thoroughly disinfected or efficiently drained. Other fractures of the facial bones are usually the result of direct violence; hence several of the bony components of the face may be broken by the same injury. Comminution is therefore frequent.

Owing to the great vascularity of the parts, union takes place quickly and with the formation of but little callus. Fractures of the anterior fossa of the cranium may be complicated with fractures of the deep portions of the facial skeleton; so may injuries of the facial structures proper be associated with lesions of the cranium and its contents. Fractures of the frontal bone constitute a facial lesion in many war injuries. It is improper to remove splinters of the bone which seem to have but slight attachment, for necrosis of such pieces is uncommon, unless the infection occurring is very virulent or antiseptic treatment delayed beyond eight or twelve hours.

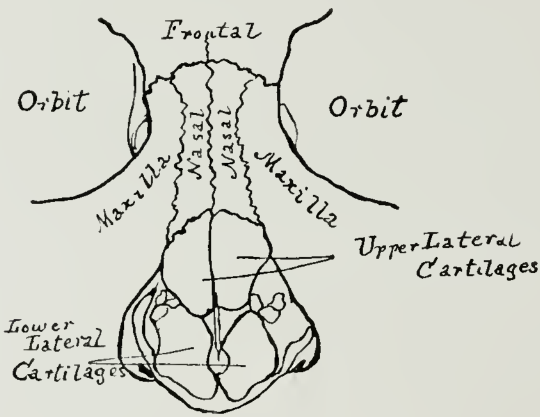


Fig. 69.— Anterior view of cartilage of nose.

FRACTURES OF THE NASAL BONES AND CARTILAGES.

Injuries of the nose producing fracture may involve, in addition to the nasal bones, the nasal processes of the superior maxilla, the frontal spine and the perpendicular plate of the ethmoid upon which the nasal bones are supported. The cartilaginous septum is often bent or broken, and the lateral cartilages may sustain similar lesions or be torn loose from the lower end of the nasal bones. The vomer likewise may be broken. It is said that fracture of the cribriform plate of the ethmoid may accompany fracture of the nasal bones. In young children the arch made by the juncture of the two nasal bones may, it is said, be flattened from the suture opening on the posterior aspect.

Fractures of the nose are often comminuted and attended with much swelling. The swelling, which rapidly appears, is liable to conceal the displacement, interfere with accurate diagnosis and obstruct nasal respiration. Congenital deviations of the septum may deceive the surgeon. Emphysema of the face may occur from air escaping into the subcutaneous cellular tissue during efforts at blowing the nose soon after the injury. This symptom needs no treatment. The tear duct may be occluded when fracture of the nasal bones is complicated by a fracture of the nasal process of the maxilla. Caries and necrosis are rather unusual, but may occur. Union generally takes place rapidly and is complete within a couple of weeks.

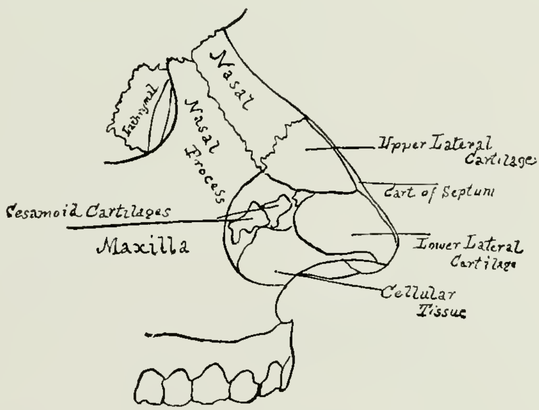


FIG. 70.— Diagram of lateral cartilages of the nose.

Recent injuries of the nose should receive early treatment, in order that deformity from unreduced fracture or dislocation of the bones and cartilages or from sloughing or mal-apposition of the soft parts may be averted. The displacement once corrected does not readily recur, especially if the parts are supported for a few days by intra-nasal plugs or tubular splints; or by nasal pins, such as are employed in maintaining the septum after correction of its deviations. Accurate adjustment of the soft tissues is to be made with sutures, when external wounds have been sustained.

The swelling occurring a few hours after a nasal traumatism obscures the condition of the septal and other bones and cartilages. Early examination with the head mirror will be often very serviceable.

Blows received on the front of the nose are liable to break the cartilaginous or vomerine septum in more or less oblique or V-shaped lines. The front fragment is then forced backward or backward and downward, so as to slide past the posterior fragment. It is this overlapping displacement which is likely to be overlooked from the swelling and bleeding incident to the injury. As a result the bridge of the nose is found later to be depressed

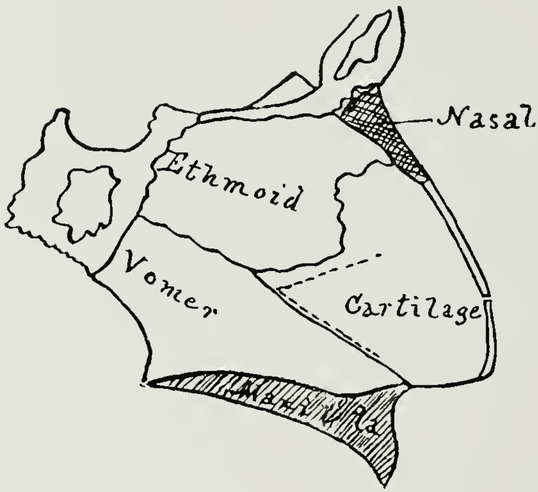


FIG. 71.—Diagram showing lines of fracture-dislocation of septum from blows on front of nose. (*Modified from Chevallet.*)

and one or both nasal chambers obstructed. The saddle nose so produced is a cosmetic defect; and the interference with nasal respiration is liable to induce mouth breathing.

When the blow is more severe, it may fracture the nasal bones. dislocate them from the ascending process of the maxilla or from the nasal spine of the frontal bone, or separate the internasal suture. These injuries not only drive the bridge of the nose inward and cause flattening or a saddle-like appearance, but the

dorsum of the organ is widened or perhaps deviated laterally. Combinations of injuries of the nasal bones, the cartilaginous dorsum, and of the septal structures give rise to much variation in the degree and character of the distortion of the nose.

When the upper lateral cartilage is dislocated from the lower border of the nasal bone, there occurs a hollow in the dorsum of the nose at about the junction of the middle and the lower thirds. It should be reduced and supported. The quadrangular, cartilage of the septum is luxated quite often from the perpendicular plate of the ethmoid. The cartilage is shoved backward

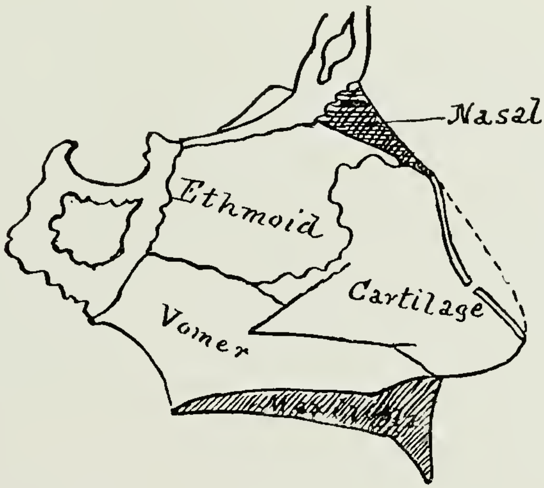


Fig. 72.—Diagram showing dispalcement from fracture-dislocation of septum and lateral cartilages of nose. (*Modified from Chevallet.*)

alongside of the ethmoid part of the septum. Thus the cartilage takes an oblique position and obstructs both nostrils; one with its posterior, the other with its anterior portion. It may be dislocated from the maxillae. These dislocations should be recognized and reduced before swelling occurs. The finger in the nares is a useful means of replacing the displaced structures. Splints, plugs of gauze, a cork, or pins may be used for retention. Fracture of the nasal bones is more likely when the force comes from the side than otherwise; hence lateral deviation as well as depression is common in nasal injuries.

When displacement from fracture or dislocation or both is discovered by a carefully and systematically conducted examination, diligent and intelligent efforts should at once be made to restore the osseo-chondral framework of the nose to its normal shape. General anaesthesia may be necessary to secure a clear understanding of the exact nature of the injury and to effect accurate replacement. Solution of cocain locally may be sufficient. When bleeding obscures the view adrenalin may be added to it.

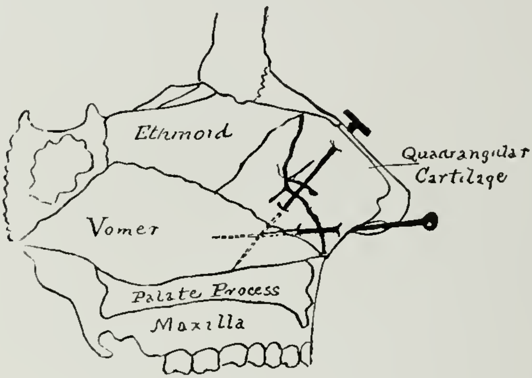


FIG. 73.— Diagram of fracture of quadrangular cartilage of nose treated by nasal pins. (*From Roberts's Modern Surgery.*)

The normal arch of the nasal bridge is narrow, and swelling of injured mucous membrane lessens it. Therefore, only a narrow instrument, such as a steel probe or grooved director or the back of a nasal saw, can be thrust under the broken or displaced bones of the dorsum to aid the surgeon in restoring the contour. Within two or three days after the receipt of injury it is usually not difficult to mould the fragments into place with the fingers of one hand, while such an instrument, introduced through the nostril, is used with the other hand to lift the fractured parts into proper relations with the rest of the nose. After the lapse of four or five days such manipulation becomes constantly more and more difficult, because of the rapid union of the bones, cartilages and mucous membrane in abnormal positions.

The broken and overlapped septum is similarly replaced with comparative ease. Its anterior portion should be grasped with a large forceps with flat parallel blades like the Adams forceps, and pulled forward; at the same time the posterior angular end of the anterior fragment should be tilted upward by depressing the handle of the forceps. This maneuver lifts the quadrangular cartilage and any attached portions of the vomer or ethmoid bones up into place and gives support to the nasal bones and lateral cartilages. Depressions in the line of the dorsum of the nose are thus eliminated. Any lateral deviation of the broken septum

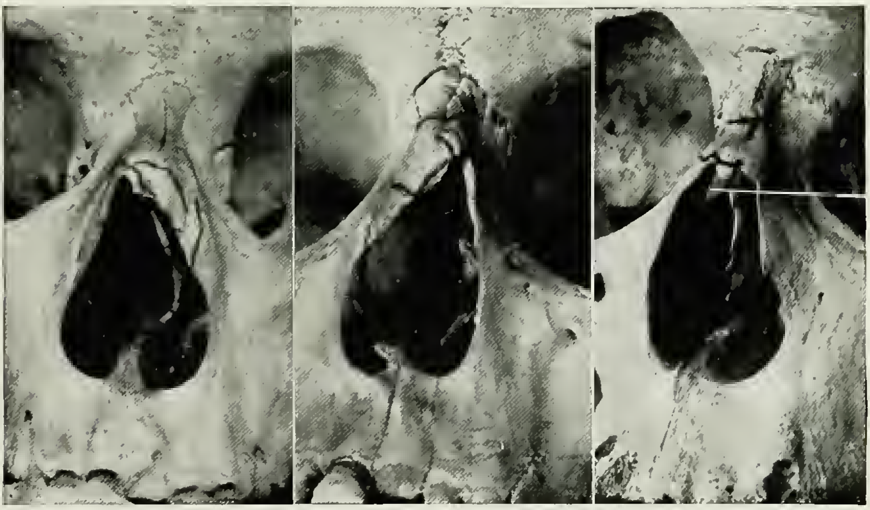


FIG. 74.—Deviations of septum from old fractures of nose. (*Mütter Museum.*) (*From Roberts and Kelly on Fractures.*)

should be corrected at the same time, and thus occlusions of the nares and nasal chambers removed. Internal nasal splints, or pins, or perhaps springs or pads adjusted to the outside of the nose, so as to make appropriate pressure, may be needed to maintain the corrected position of the injured tissues. The last named instruments may be attached to head bands. They are, however, seldom if ever required. Nasal pins or intra-nasal supports are less conspicuous, and, if judiciously adjusted, answer the purpose well in nearly all cases. Instead of the pin a rubber

thread may be carried across under the replaced bones; and shot, protected by rubber disks, be clamped upon its ends to make sufficient lateral pressure. Then the swelling of the soft parts stretches the rubber band and injurious pressure by the shot on the skin is avoided.

The mucous membrane lining a broken nose seldom needs attention except that the nasal cavities should be more or less frequently flushed out or cleansed with sterile normal salt solution or some mild antiseptic spray or wash, such as the compound solution of sodium borate.

Old unreduced fractures and dislocations require osteotomy or refracture and readjustment. Much can be done by dividing cartilage and bone from within the nose. The operator punctures the mucous membrane in the necessary places and by thrusting small saws or chisels under it reaches the bone or cartilage to be divided. The overlapping soft parts may be detached from the bones and cartilages by the free use of a tenotome. When necessary, small external incisions may be made to admit a small saw or chisel or a tenotome. These often need no subsequent suture to close them. To uncover more extensive areas incisions and flaps may be made with small, sharp knives. After the bones have been divided and the readjustment has been completed, fine sutures of horsehair or silk restore the cutaneous surface. The scars soon disappear, especially if the cut in the skin has been made obliquely to the surface.

Sometimes saddle noses due to fractures can best be corrected by subcutaneous paraffin injections. Instead of using hot paraffin, cold or more or less solid paraffin may be used, as in other cases of sunken bridge, if the dangers of embolism are feared. This material is best injected with a syringe, having a piston driven by a screw attachment, and needles of large calibre.

H. P. Mosher has given a good description of the mechanism of the deformities due to fractures and luxations of the nasal bones and cartilages. He has made valuable suggestions for unlocking the impacted bones and reducing the displaced or luxated structures.

In old, uncomplicated lateral deviation of the bony bridge of the nose Mosher makes a small incision in the skin at the outer border of the lower part of the nasal bone. With a chisel about

one-eighth of an inch wide he cuts this bone from the ascending process of the maxilla. By slipping up the skin this can be done through a very small incision. He then turns the chisel at right angles and cuts the nasal bone loose from the frontal. This detachment is made on both sides of the nose and must be complete so that the bony nasal bridge is freely movable. It is returned to its normal position in the median line and held there by some form of external splint. Modelling compound or superimposed layers of adhesive plaster will usually be sufficient.

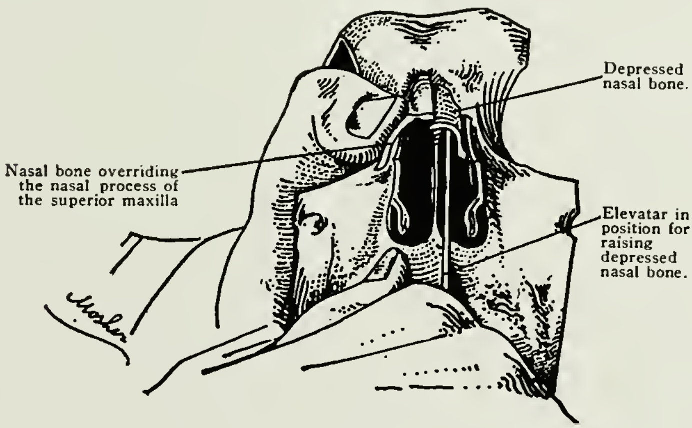


FIG. 75.— Method of reducing with thumb and elevator fracture-dislocation of nasal bones. The right nasal bone overrides maxillary process, the left is depressed and caught under its fellow and under the left maxilla. (*H. P. Mosher.*)

When the lateral deformity involves the cartilaginous as well as the bony bridge, the septal cartilage is usually bent, and, therefore, occludes the naris on one side. Mosher says that the perpendicular rectangular deviation makes a knuckle in the quadrangular cartilage. This prominence should be dissected out submucously. He stops removing the cartilage a quarter of an inch from the top of the cartilaginous bridge. If the upper lateral cartilage is displaced, it is removed by dissection within the nose. When these intra-nasal procedures are completed, the nasal bones are chiseled loose as described above and returned to their normal median situation. There may remain a protuber-

ance, due to the prominence of the nasal process of a maxilla, from which a nasal bone has been chiseled loose. This is cut off with a chisel, entered through the cut made to get access for the nasal osteotomy, and then is shoved down toward the interior of the nose.

Sometimes there remains lateral deformity at the point where the bony bridge and the cartilaginous bridge join. The skin should be cut at this point and a chisel used to separate the quadrangular septal cartilage from the under surface of the tip of the nasal bone. If this maneuver is not sufficient to allow the operator to straighten the nose, a half inch incision should be made downward and backward into the perpendicular plate

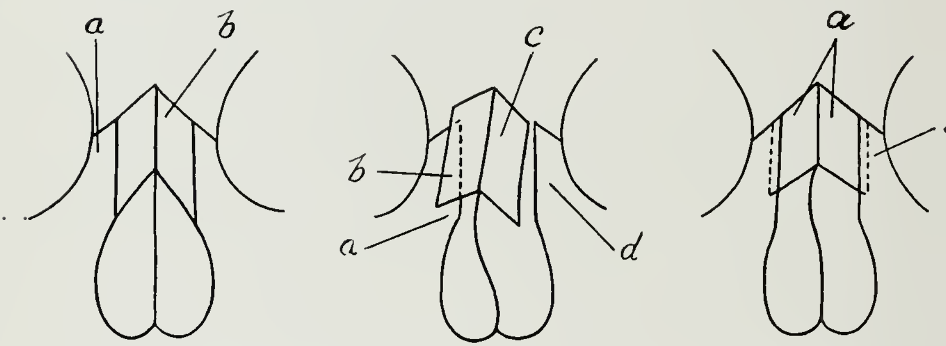


Fig. 76.— Diagram showing relation of nasal bones to nasal processes of superior maxillae. *a,* maxillary process; *b,* nasal bones. 1, normal; 2, fracture-dislocation of nasal bones toward right, over-riding maxillary process; 3, depression of nasal bones beneath maxillary processes. (*H. P. Mosher.*)

of the ethmoid. Then a straight nose may usually be obtained by modeling. Proper retentive appliances should be employed for two or three days.

If the external incisions described for replacing nasal bones after mal-union following fracture, are undesirable, the nasal bones may be loosened from their attachments to the maxillae and frontal bone by working within the nose. The mucosa is incised at the lower border of each nasal bone and the muco-periosteum detached by elevators introduced through the respective naris. The skin and periosteum is similarly detached from the upper surface of each bone by similar intra-nasal manipula-

tion. The nasal bones are then in turn grasped by strong, flat forceps, thrust through the nostril, and are wrenched from their neighbors. They are then moulded with the fingers into the proper site to render the nose straight and are maintained there by splints or similar devices. This superiosteal method is more troublesome than that by cutaneous incision. It is probably not as good. The external route is more surgical; and as the scars made by its adoption are inconspicuous after a few months, it is usually the preferable procedure. Patients should be cautioned against violently blowing the nose or snuffling, for displacement may thus be caused.

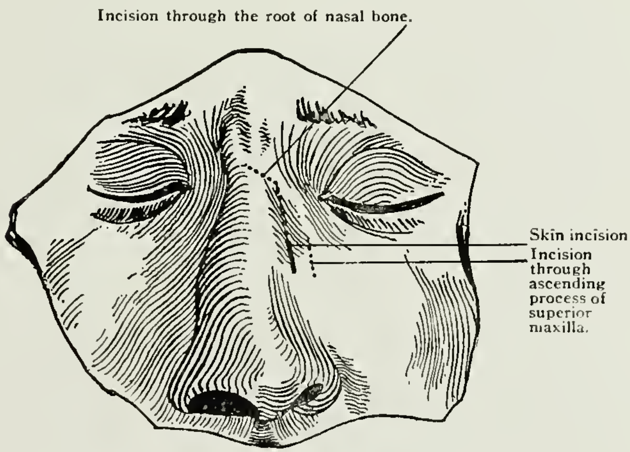


Fig. 77.— Diagram to illustrate correction of lateral deformity of the nose by direct chiseling of bone. Dark line shows skin wound; dotted lines bone incisions with chisel. (*H. P. Mosher.*)

If profuse hemorrhage occurs, the nostril on the bleeding side should be plugged. To the end of a strong string, about eight inches long, a disk of moistened sponge, about three-fourths of an inch in diameter and three-eighths of an inch in thickness, is firmly tied. This sponge is oiled, and, by forceps, pushed into the nostril and along its floor till it reaches the posterior nares. Upon the string hanging from the anterior nostril four or five similar disks of sponge are strung like beads and consecutively crowded into the nose until the cavity is filled. After the lapse of twenty-four hours the disks are removed one by one.

FRACTURE OF THE ZYGOMATIC OR MALAR BONE AND ZYGOMA.

These injuries are readily recognized by the deformity and the irregular outline, which can be felt by the fingers. If fracture of the malar bone extends into the floor of the orbit, the superior maxillary nerve may be injured, subconjunctival ecchymosis appear, or protrusion of the eyeball from intra-orbital hemorrhage take place. Extensive fracture with dislocation of fragments of bone may cause lesions of eyeball or optic nerve or of intracranial structures. In fracture of the zygomatic arch the mouth may not open freely, because the displaced fragments obstruct the movement of the coronoid process of the lower jaw. Pain and swelling sometimes stimulate or increase this disability.

The treatment consists in replacement by pressure of the fingers upon the cheek or within the mouth. If necessary, an incision may be made for the introduction of a lever under the displaced bone, which is easily lifted into place.

When the malar bone is driven into the maxillary sinus, the surgeon may introduce the point of a steel urethral bougie into the sinus through an opening cut with a chisel in the anterior wall of the sinus under the upper lip. With this curved instrument as a lever, he can readily thrust the malar bone into its normal site.

FRACTURES OF THE MAXILLARY BONES.

The two upper jaw bones are connected directly or indirectly with many other bones of the face and cranium for affording support and protection to soft parts and sense organs and of acting as a rigid foundation, against which the mandible may strike during mastication of food. They constitute the central portion of the face; and, although hollowed by the maxillary sinuses, have immovable sutures uniting them to surrounding bones and to each other. Their individual and combined strength is augmented by the manner in which their borders and processes are sustained by firm contact against the frontal, molar, or palate-bones. Displacement of fragments is not often due to muscular action, but to the vulnerating impact or to gravity.

Military projectiles, especially shrapnel and pieces of shell, may cause extensive injuries of the maxillary regions; often tearing away large portions of bone and soft tissue. The face may

be almost entirely torn from the cranium by a transverse fracture. The cavities of the face are frequently opened, and the wounds contaminated by foreign bodies imbedded in them. Contact with

Fig. 78.— Shell fracture of maxilla with loss of bone, five teeth and soft tissues of lip. Plastic treatment delayed for a time until infection had been controlled and cicatricial contraction had occurred, leaving defect in upper lip. Photograph shows incisions made across cheeks to permit approximation of remains of upper lip by sliding tissues toward median line. Several operations were done on this patient. It represents intermediate plastic operation before too much delay had permitted greater deformity.
(*Courtesy of Dr. Thos. G. Aller, Jr.*)

nasal, oral and conjunctival fluids occurs. The moisture of these secretions makes infection more likely in the presence of foreign material carried into such wounds than would be the case in regions readily kept dry.

In civil life, the alveolar, nasal and other processes of the maxilla are the portions most frequently the seat of fracture. These injuries occur especially in connection with coincident breaks of the adjacent bones. There may be rigid impaction of the fragments with consequent distortion of the orbital, nasal,

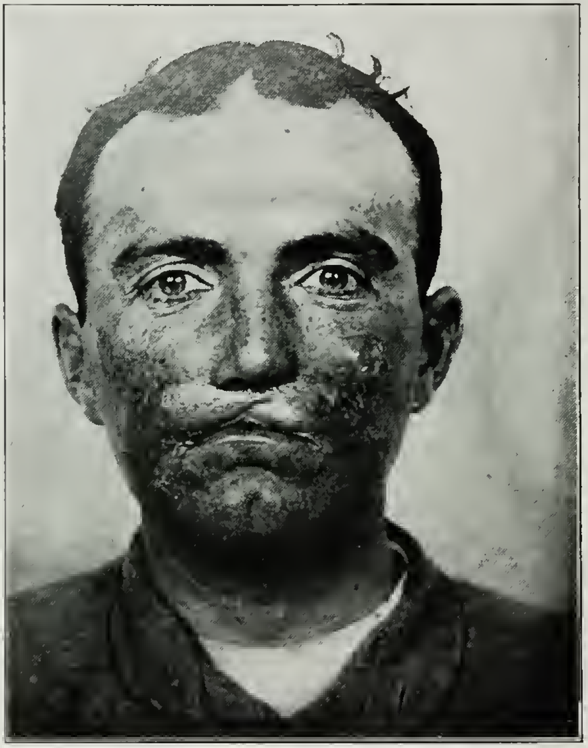


Fig. 79.— Later appearance of same patient after swelling had disappeared and scars had become less marked. Upper lip is much improved in shape and its tightness when compared with lower lip much nearer normal. Upper lip was furnished with a mucous border made from a bridge strip of mucosa ½ inch wide dissected from lower lip with its ends left attached to the inside of cheeks. The middle of this flap was turned up and stitched to the denuded under surface of the new upper lip. Later the ends of the mucous membrane flap were cut from their attachments to the cheek, and the mouth split at the corners so as to make the new upper lip with its newly obtained mucous lining match in length and width the lower lip.
(Courtesy of Dr. Thos. G. Aller, Jr.)

FIG. 79a.—Gunshot injuries of upper lip and maxillae, treated by immediate excision of contaminated structures. (*Courtesy of Dr. Thomas G. Aller, Jr.*)

FIG. 79b.—Slight deformity of upper lip and maxillae when tissues immediately excised and wound treated antiseptically. Same patient as in previous Fig. 79a. (*Courtesy of Dr. Thomas G. Aller, Jr.*)

oral or other cavities of the face from changes in the bony partitions.

The lachrymal canal, the orbit and the superior maxillary vessels and nerve may sustain traumatic lesions as an accompaniment of the maxillary fracture. Intermaxillary separation may happen.

In non-infected fractures three or four weeks is sufficient for union. Even in infected fractures good results will often be obtained, if restoration of the facial contour is obtained by replacement of fragments. It is usually unwise to remove comminuted bone pieces, even if deprived of periosteum, in the early stages of treatment, because the facial structures show great vitality. If necrosis occurs later, the periosteum has at that time become thickened and manipulation for removing the sequestra causes less damage to the osteogenetic layer than if the pieces were taken away immediately after injury. Careful inspection of facial contours, interior illumination of the mouth and nose,

FIG. 80.— Wiring maxillae and mandible with wires around necks of teeth. (*Blair from Gilmer.*)

and subsidence of swelling may be required to give a full realization of the actual condition of the bones. Digital pressure, and x-ray examintion are valuable aids.

Grave laceration with profuse bleeding, comminution of several bones and even detachment of great blocks of tissue from adjoining parts of the skeletal framework occur in war. Asphyxia from swelling or unchecked hemorrhage, difficulty in swallowing water and food, localized or general emphysema of subcutaneous cellular fascia may complicate the surgeon's problem. Perforating wounds from bullets are in some sense less likely to cause infection than in other parts of the body where clothing and mud may be driven into the wound.

So far as horizontal alveolar fractures are concerned the management is similar in the maxillary and the mandibular regions Fixation is obtained by using one jaw as a support to the other. This may be done by holding the teeth in occlusion with a head and chin bandage, with a strap of adhesive plaster carried under the chin, or by wiring the lower jaw against the upper.

Fig. 81.— Gunshot fracture of maxillae supported after the method of Marshall. (*Courtesy of Dr. H. W. Scarlett.*)

If there is possibility of patients vomiting from seasickness or other cause, wiring in this manner is very dangerous, unless long ends of the wires are left protruding from the mouth so that the patient or an ever-watchful attendant may untwist or cut the wire at the earliest symptom of nausea. It is reported

that many soldiers have been suffocated with vomitus because of inability to open their wired jaws while crossing the English channel from France.

Displacement in fractures of the upper jaw, if overcome by manipulation, is as a rule not likely to recur. It may happen in extensive lines of break, and in complete separation of the two upper jawbones at the median suture, with fracture or disjunction about the sutural connections with other bones. Mandibular fractures, on the other hand, are often exceedingly rebellious when attempts at surgical fixation of fragments are made.

Marshall's method of supporting the maxillae in transverse fracture of the face is valuable. This splint is constructed by making impressions of upper and lower teeth with modeling composition and imbedding heavy steel wire arms at the sides for giving attachments to occipital and vertex bandages. A hard rubber or metal dental splint is then constructed after this model. Comminuted fractures may require wiring or nailing the fragments into proper relation with one another or to the other facial bones. Ombredanne illustrates a possible method of maintaining coaptation with a swaged metal dental splint having bars attached to a head cap.

Painstaking removal of foreign bodies, especial care in evacuating clots of blood from the sinuses, nasal chambers and mouth, and providing for thorough drainage, when the probability of retention of secretions or blood is evident, are of much importance in injuries of the maxillae. Intelligent cleaning of teeth and mouth is of importance. Suturing with catgut or wire, or fixation by means of nails or screws will be needed in some extensive fractures, disjunctions, or luxations. Loose teeth in fractures of moderate severity should be left in place. They often become firmly fixed. If a loose tooth is found to be situated in the line of fracture, it should be removed. Its vitality has been almost certainly destroyed, and it is liable to retard union.

The more severe fractures, and those in jaws without available teeth for wiring, may need an interdental splint to be constructed by a skilful dental surgeon. Various forms of splint similar to those used in fractures of the mandible are available. Transverse fractures of the upper jaws, causing the middle and lower

part of the facial skeleton to drop from the base of the cranium, may be retained in position by suturing the soft parts, and then applying a splint to the upper teeth and roof of the mouth and supporting it by means of lateral arms attached to a hood or cap

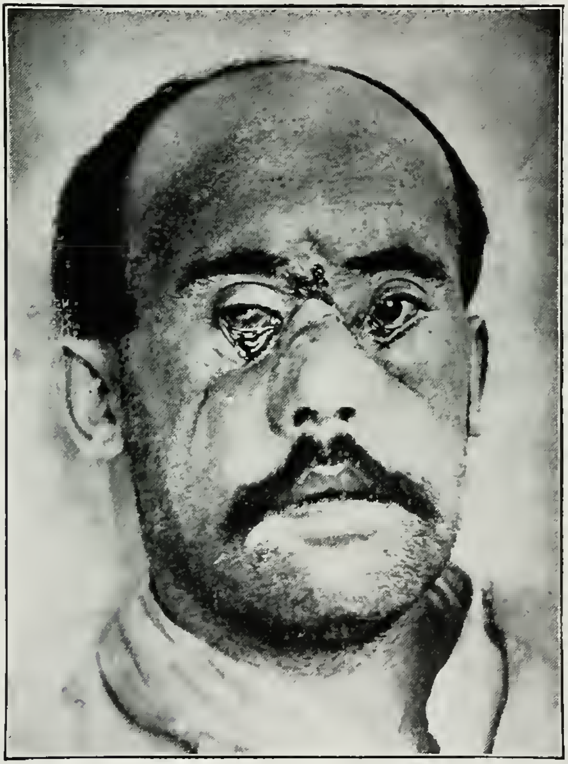


FIG. 82.—Later stage of same patient (Fig. 81) showing value of prompt replacement of soft tissues and fragments of bones.
(Courtesy of Dr. H. W. Scarlett.)

fitting the top of the head. Often a few sutures will hold structures sufficiently together and oozing of blood may be allowed to occur between the stitches. If surgical attention has been received too late to prevent the contamination being fol-

lowed by the stage of infection, irrigations and free drainage must be adopted.

Liquid food is given in maxillary fractures through crevices between the teeth, by passing the tube from a funnel between the cheek and the lower alveolar arch as far as the last molar teeth.

The possibility of fracture of the base of the cranium, intracranial hemorrhage, and cerebral or nerve trunk laceration must be borne in mind in studying fractures of the facial bones from penetrating missiles or heavy blows. Ophthalmoscopic examination, inspection of the pharyngeal wall and the membrane of the

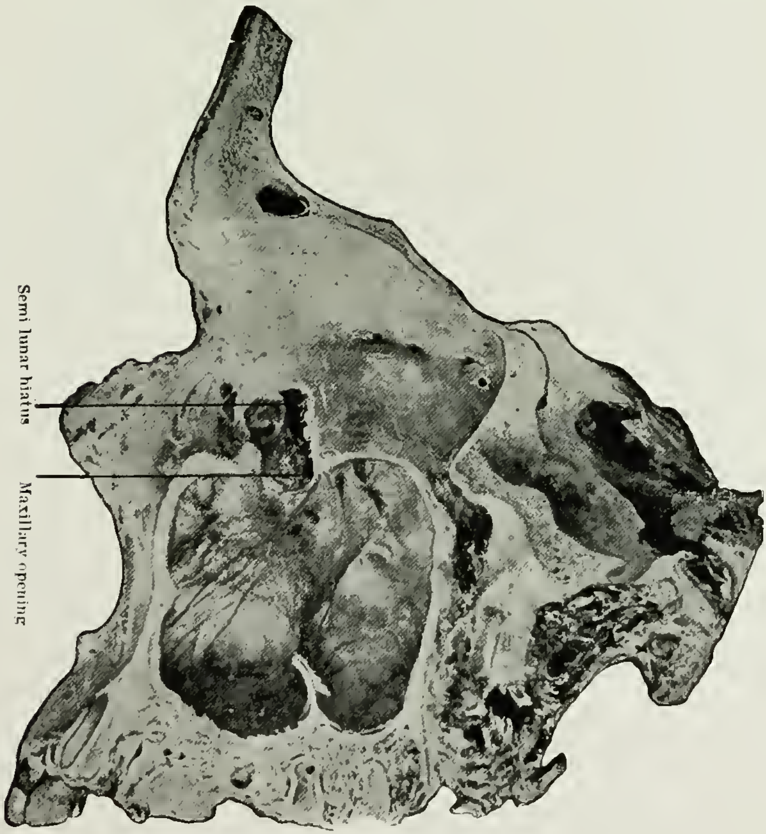


FIG. 83.— In this specimen the sinus extends nearly to region of canine tooth. (*From M. H. Cryer.*)

tympanum, and tests of the nerve distributions should be part of the surgeon's routine investigation.

Purgation, elevation of the head, administration of hexamethylenamin and potassium bromide are advantageous at such times. Trephing also will be demanded in some cases. Perhaps lumbar puncture may assist in establishing the diagnosis of cerebral damage in doubtful cases.

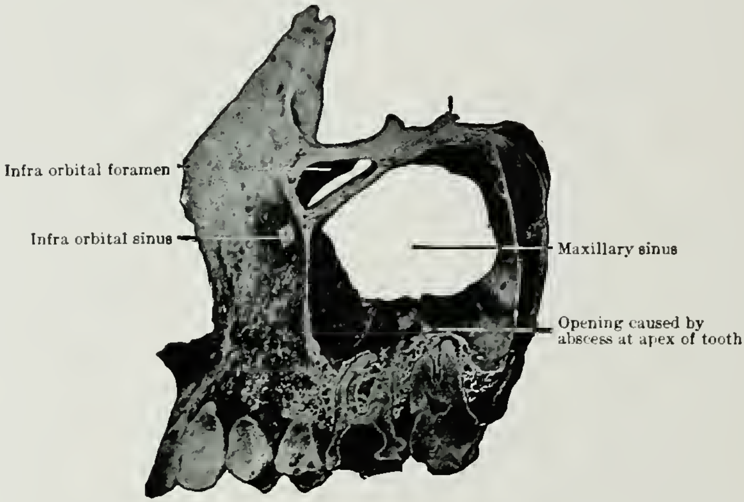


Fig. 84.—Specimen showing maxillary sinus extending forward only a little beyond first molar tooth. (*From M. H. Cryer.*)

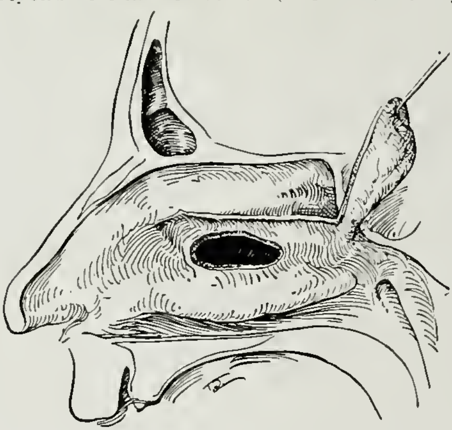


Fig. 84a.—Middle turbinal or concha elevated to show opening from middle meatus of nose into maxillary sinus. (*Geo. E. Shambaugh from Surgical Clinics of Chicago.*)

CHAPTER XII.

FRACTURES OF THE MANDIBLE.

Military practice is particularly concerned with the proper treatment of fractures of the lower jaw or mandible. The face is especially subject to wounds from projectiles in trench warfare, which has been such a characteristic feature of the present conflict in Europe. The integrity of the lower part of the face is essential for perfect phonation, respiration, mastication and

Fig. 85.—X-ray plate showing right side of mandible with extensive necrosis due to acute osteomyelitis. All of the teeth of the mandible were extruded in two weeks from disease of the body from angle to angle.

A good illustration of X-ray appearances after infected top gunshot fracture with loss of substance. (*From R. H. Ivy.*)

alimentation. Its contour cannot be much disturbed by loss of bone or soft parts without seriously lowering the earning capacity of the soldier who returns to peaceful life. Normal mobility of the mandible, proper occlusion of the teeth and restoration of the lineaments of the human countenance are eagerly sought by army and navy surgeons. These desiderable ends are often difficult of attainment.

In civil practice the mandible is more frequently broken than any other bone of the face. The seat of fracture is generally toward the anterior part of the body of the bone. Fracture of the ramus is comparatively rare, and fracture of the condyle and coronoid process even more unusual. The body of the bone is said to be weaker and more easily broken near the root of the canine tooth and the mental foramen than elsewhere. Loss of teeth and consequent atrophy of the alveolar process may reduce the normal strength of the bone in other situations and be the

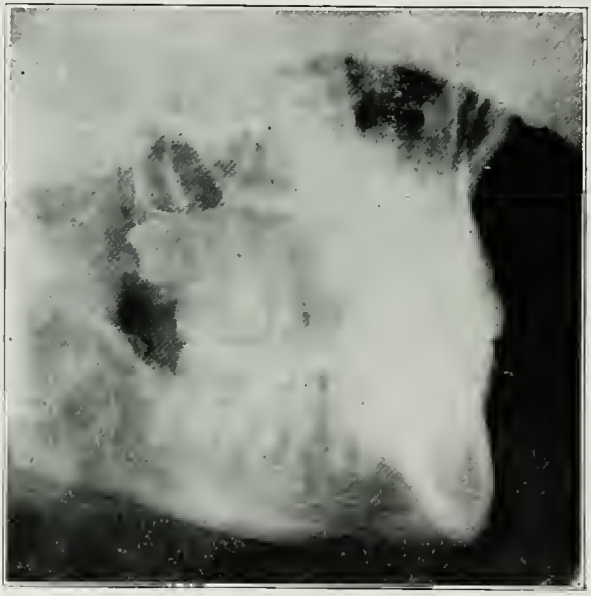


Fig. 86.—Roentgenogram of left side of face showing anatomic landmark and an impacted upper third molar. (*From R. H. Ivy.*)

predisposing cause of fracture. These statements exclude from consideration mere splintering of the alveolar process often produced by pulling teeth and by other causes. Double fracture of the lower jaw is not uncommon. Horizontal fracture of a considerable portion of the alveolus should not be forgotten as a possibility.

When the body of the bone is broken the fracture usually communicates with the mouth through a tear of the gum. The fracture becomes in such cases, therefore, an open one, and is accompanied by suppuration because it cannot be kept aseptic. Suppuration is usually not very great. The close attachment of the

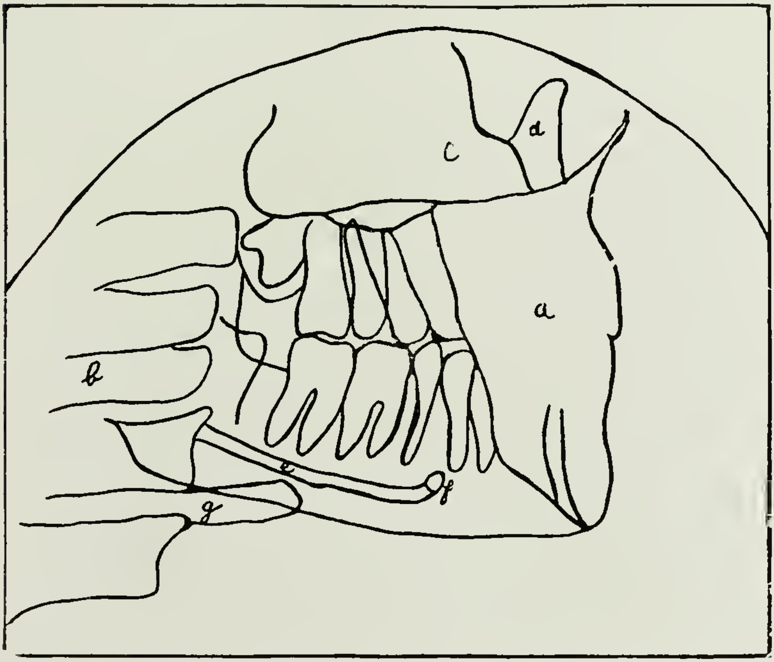


FIG. 87.—Outline diagram of previous roentgenogram of left side of face showing normal anatomic relations and an impacted upper third molar on left side. *a*, portions of maxilla and mandible overlapped by shadow of opposite side; *b*, vertebrae; *c*, maxillary sinus and nasal fossæ; *d*, coronoid process of right side of mandible; *e*, mandibular canal; *f*, mental foramen; *g*, hyoid bone. (*From R. H. Ivy.*)

fibrous tissue of the gum to the alveolus is a sufficient explanation of this frequent complication. When the bone is comminuted or drainage not well maintained during treatment, infection and prolonged suppuration are common. The inferior dental nerve may be torn or bruised when its canal is involved in the fracture. Anaesthesia of the corresponding half of the lower

lip and chin is the result of this nerve lesion. Gunshot fractures situated in any part of the bone are perforated, comminuted and open. Hence infection with osteomyelitic necrosis is a usual complication.

The displacement and unnatural mobility in fracture of the body are easily detected, but the surgeon must bear in mind the possibility of malpositions of the teeth from irregular development and eruption, and that unerupted and impacted teeth quite often exist in adult jaws. The x-ray plate will often be required

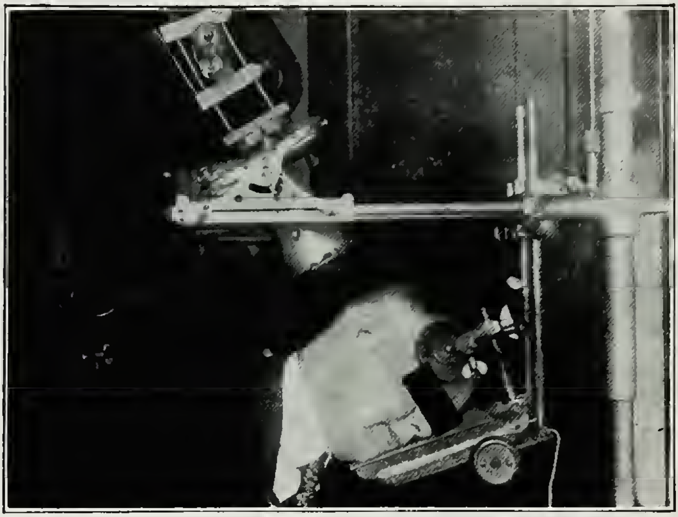


Fig. 88.— Position of head and angle for left side of maxillae when Eisen plate rest is used with stand for taking roentgenograms of jaws. (*From R. H. Ivy.*)

to prove the seat, or even the existence, of mandibular fractures. In single fracture of the body away from the median line, the anterior fragment is apt to be displaced inward toward the mouth. In double or bilateral fracture of the body, the middle or chin portion may be drawn downward by muscular action. The displacement in fracture of the ramus may be most easily recognized by the finger in the mouth.

Pain, often increased by motion or deglutition, and excessive secretion from the mouth, are observed in fracture of the lower

jaw. Perhaps the increase of saliva and mucus is largely apparent; the excess observed may be really due to a want of proper control of these fluids within the mouth. Fetor from decomposing food, pus and other secretions is often marked. Abscesses about necrosed pieces of bone, fistulous tracts and ulceration of the mucous membrane may add to the discomfort of the patient, who perhaps becomes greatly debilitated by swallowing foul secretions and being deprived of a fully nutritious diet.

Union of ordinary fracture of the jaw takes place in about five weeks. The prognosis, even in bad cases, may be good. Even if teeth are lost the solid union which occurs may give a good basis for the adaptation of artificial teeth. This is not the case in gunshot or other complicated injuries.

The shape, situation and function of the lower jaw and its relation to other facial structures lend to the vulnerating missile an extraordinary opportunity for serious complicating lesions. Much of the difficulty found by the surgeon in his attempt to restore the patient to his former military efficiency comes from the complications arising from sepsis. This danger is common to all war wounds and needs no special consideration. The removal of projectile and contaminating foreign substances, the prevention of infection by early aseptic excision of damaged tissues, the use of chemical antiseptics and the evacuation of cavities containing albuminous fluid liable to putrefaction should differ to but a moderate degree from the same activities in other regions. It may be said, however, that in the face an abundant vascularity, a free anastomosis of blood vessels and the consequent unusual resistance to microbic attack permit greater retention, at the hands of the surgeon, of splinters of bone and of partially devitalized soft tissues than is wise in the limbs or trunk. The difficulty of maintaining a dry wound after reduction and fixation of an open or an infected fracture adds to the possibility of subsequent suppurative inflammation and septic necrosis unless free escape is provided for the drainage of saliva. Then the flow washes the wound and may be serviceable. Establishment of free drainage by incision below the mandible, with introduction of tubes, so that gravity may aid in the escape of infected discharges, will do much to obviate the evil of saliva, food and nasal mucus reaching

the wounded surfaces. Giving water and liquid food through a funnel and soft rubber tube, for a week or ten days, may be very valuable as a preventive measure in fractures accompanied by wounds likely to assume septic complications.

When one recalls the shape and function of the mandible, the real reason for its frequent malformation after union of a fracture is obvious. The bone reminds one of a crude horseshoe, with a high caulk at each end, applied to the skull upside down. Each caulk terminates in two projections. The posterior projection ends in a cylindrical knob for articulation with the temporal bone of the cranium, the anterior is flattened for the grasp of the tendinous insertion of the temporal muscle. This rude model of a horseshoe is furnished with sixteen sockets, on the same surface or edge as that from which the caulks arise, for the roots of the lower teeth. When man opens his mouth for eating, drinking, or speaking, the mandible moves downwards from the cranium and face as a hinged bottom drops from a box. The axis of motion is a transverse line drawn through the two rami a little above and a little behind the third lower molars. In addition to the open and shut movement of the jaws, there occur during mastication crushing and grinding motions of the molar teeth caused by the action of the masseter and pterygoid muscles.

It is fortunate for patients who sustain fracture of the lower jaw (mandible) that the two upper jaw bones (maxilla) above furnish an immovable anvil against which the teeth of the mandible strike in chewing food. This anvil-like mass of bone and teeth may be utilized by the surgeon as a splint to support and steady the broken lower jaw after its fragments have been so replaced as to reconstruct the dental arch. This may be done with muslin bands furnished with hooks glued to chin and cheeks and then laced.

It is an axiom that the broken mandible should have the contour of its body or arch readjusted in a manner to reproduce the occlusion of upper and lower teeth existing prior to the occurrence of fracture. The surgeon thus has his patient's upper jaw for a standard, by which to assemble the various fragments of the mandible found in a gunshot or a comminuted fracture. This happy condition may be unattainable, because many patients have previously lost teeth in one or both jaws, or some teeth

have been carried away by the gunshot force which produced the fracture awaiting reduction.

The usual fractures occurring in the body of the mandible are not difficult to reduce and keep reduced, if both jaws have intact teeth. The difficulty of reduction is usually not great in other circumstances, unless there has been great loss of teeth or marked ablation of bone by the trauma of the projectile. One readily obtains a proper occlusion of the teeth, and then holds the mandible against the maxillae by means of an external bandage, chin-

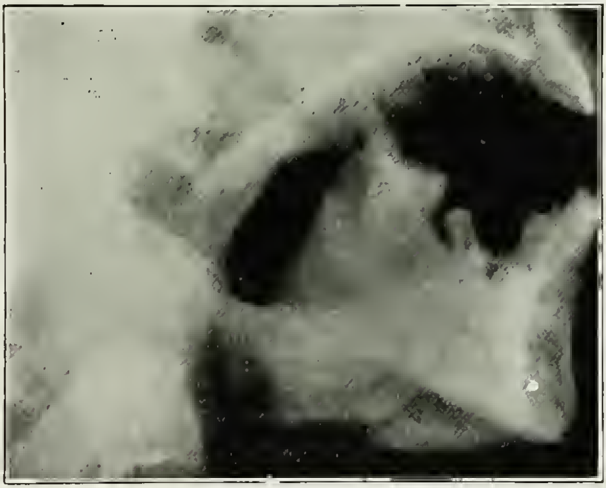


Fig. 89.—Roentgenogram of fracture of left side of mandible near canine tooth with very few teeth present. A very common site for fracture of that bone. (*From Interpretation of Roentgenograms, by Major Robert H. Ivy.*)

strap, or splint. In comminuted injuries the reduction is not apt to be easy; and its maintenance may be difficult. The absence of teeth, even if only a few have been lost, prevents very often the successful employ of the upper jaw as a supporting splint. The operator must then devise a method of fixing firmly the fragments in apposition by means of interdental or intermaxillary splints or by the adaptation of some mechanical connection or bridge between the major fragments.

The general surgeon may undertake the treatment of severe fracture of the body of the mandible with some hesitation,

because he realizes his unfamiliarity with dental manipulations within the mouth. Much of this is due to a want of consideration of the relations of the teeth to the fracture and a neglect of a study of the mechanical and anatomical needs of the injury.

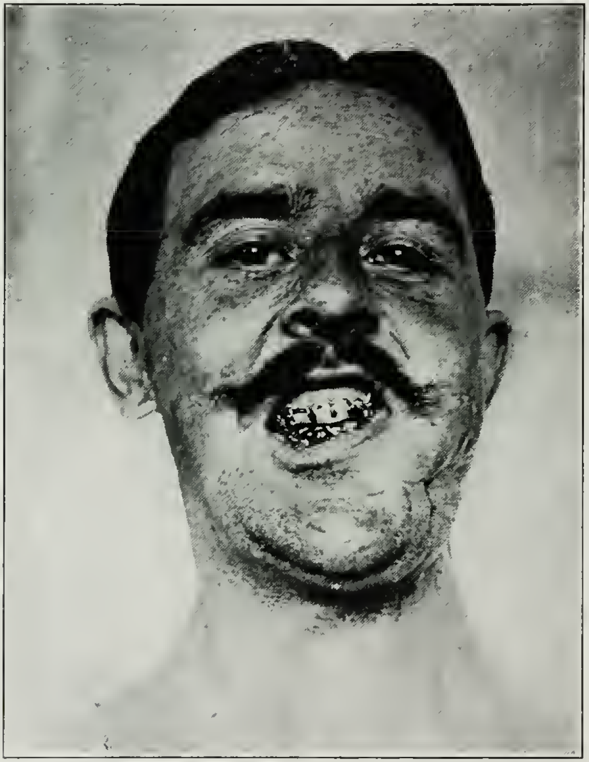


FIG. 90.—Shell fracture of mandible; one week old when admitted to hospital for treatment. Loss of bone from angle to a point about 1½ inches forward. Infection present. Great injury to soft tissues. Cicatricial contraction prevented with intermaxillary splints with hooks and rubber bands, thus maintaining normal occlusion of teeth. (*Courtesy of Dr. Thos. G. Aller, Jr.*)

A dental surgeon may have, it is true, a manual dexterity and an experience, which give him an unusual facility in treating mandibular fractures; but a surgeon without a sufficient degree of alertness and deftness to learn the few needed manipulations

must be a sorry surgeon also in other technical procedures. The principles by which fixation of mandibular fragments is to be obtained can be in all but most exceptional cases, readily learned by a painstaking and conscientious operator. It is well for us to take steps to acquire such knowledge.

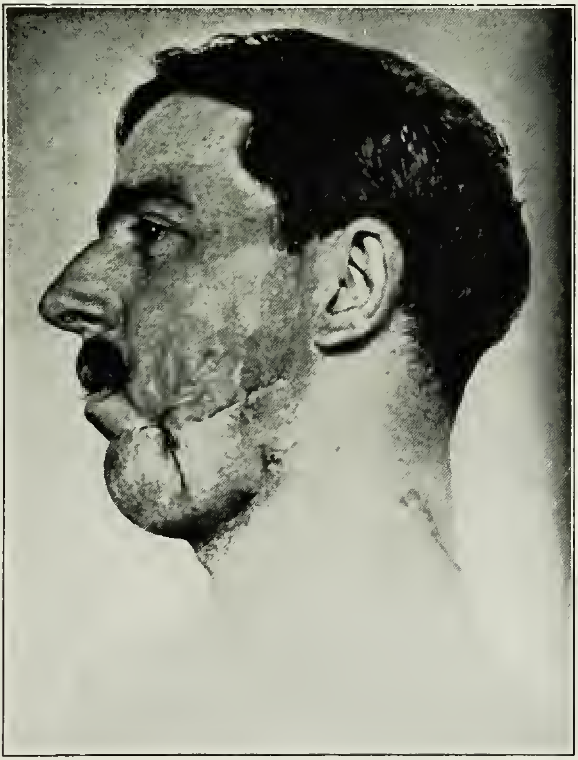


FIG. 91.— Profile view of same patient, 3½ months later, showing satisfactory position of jaws and mouth. Note the extensive wounding of the cheek and neck, which accompanied the fracture. Plastic repair of face still required. (*Courtesy of Dr. Thos. G. Aller, Jr.*)

Reduction of the fracture by pressure of the fingers on the teeth is usually easy, though occasionally comminuted fragments or displaced teeth may cause interlocking and require removal before correct apposition is obtained. Teeth which are simply

loosened should not be removed unless they impede reduction or are situated in the line of the fracture. In these circumstances it is wise to extract them. The normal relation of the upper and lower teeth in most mouths brings the upper incisors in front of the lower when the mouth is quietly closed. Generally there is little tendency to displacement after ten days have passed. Hence, after the lapse of about two weeks, the dressings may be removed and the patient given an opportunity to attempt mastication cautiously in order to demonstrate whether the fragments have been adjusted in a manner to give the best use of the teeth in chewing. Any slight change in adjustment is then possible, for consolidation will not be complete.

After reduction, uncomplicated fractures of the jaw are to be treated by keeping the upper and lower teeth in contact by means of the figure-of-eight bandage of the occiput and chin, or some similar apparatus to restrain movements of the mandible. This is not difficult if all or nearly all the teeth are present in both jaws. The maxilla can then be utilized as a dental splint for the broken mandible. The mouth must be cleansed with disinfectant washes. Feeding, as in fracture of the upper jaw, is accomplished by introducing milk and broths through the crevices between the teeth, or through a tube passed behind the last molar or through the nostril. The hair and beard of men should be closely cut before the bandages are applied; otherwise they are apt to slip or be very uncomfortable.

When the simple bandage does not give sufficient firmness to cause maintenance of correct apposition, or when the lateral pressure of the bandage causes overriding, it is well to adapt a moulded splint to the outside of the chin. Pasteboard, felt, leather, gutta-percha or gauze stiffened with gypsum are the proper materials from which to construct a hollow cap to fit the front and lower surface of the chin. The splint should extend on each side nearly as far back as the angle of the jaw; it may need a crescentic portion of its posterior edge cut away in order to avoid pressure on the throat above the larynx. The splint is padded and placed over the chin and held in position by the bandage. Before applying the bandage the splint may be fixed in position by carrying a band of rubber adhesive plaster over the splint and as high up on the cheeks as the zygoma. These

dressings are not satisfactory in the complicated injuries to the mandible usually seen in shrapnel and bomb wounds.

If the tendency to displacement is persistent, wiring the fragments together or fixation by a dental splint becomes necessary. A strong silver or iron wire may be fastened around several teeth on each side of the fracture; in rebellious fractures or in toothless jaws the ends of the bone may be drilled and wire sutures passed through. Dental splints are splints worn inside the mouth and so fitted to the teeth and alveolus that motion at the seat of fracture is prevented. An impression of the teeth and alveolus of the mandible is taken while the fragments are held in position. A similar impression may be made of the maxilla above. By means of these impressions a splint of metal or vulcanized rubber is constructed which contains indentations into which the teeth accurately fit. If such a splint is applied to the teeth of the broken mandible and fixed to it so that the jaw bone is kept continually in close contact with it, motion at the seat of fracture is impossible, because the crowns of the teeth are buried in indentations on the surface of the splint.

There are several methods of securing the splint to the jaw. Probably the best is to have the upper surface of the splint fitted to the upper teeth. The jaws are then closed upon the splint and kept in that position by an occipita mental, often called Barton bandage. Lateral motion is prevented by the depressions into which the teeth fit. Such an interdental splint can be made thick enough to permit openings for feeding between the upper and lower surfaces of the splint. Instead of using the upper jaw for immobilization the splints may be fitted to the lower jaw alone and attached by rods coming out of the corners of the mouth to a splint under the chin. A simple splint is made by softening a gutta-percha strip in hot water, moulding it to the crowns of the lower teeth so as to overlap the adjacent gum and hardening it by cold water. Such a splint may be held in position by wires carried by means of needles through the muscles and skin of the chin and twisted under the mandible over small rolls of plaster or pieces of cork. In subjects who have lost all or nearly all their teeth, interdental splints moulded to the atrophied gums present about the only efficient means of maintaining immobility. In all forms of splints greater immobility will as a rule be ob-

tained by bandaging the jaws together. If desirable, gutta-percha wedges may be placed between the jaws on each side of the mouth in order to have a space in the middle for introduction of food. A crude form of interdental splint may be made of cork cut to fit the teeth of the two jaws.

Most gunshot fractures of the mandible will be open and therefore liable to become contaminated and later infected. Besides a fracture large areas of skin and muscle may be detached from the bones of the face in gunshot wounds. The raw surfaces should be well painted with tincture of iodine, di-chloramine T or other antiseptic and foreign bodies thoroughly removed as soon as possible after injury. These fractures should be reduced immediately and the fragments fixed. Even a temporary fixation of fractures is of distinct value as a preliminary to reconstruction of the facial outlines.

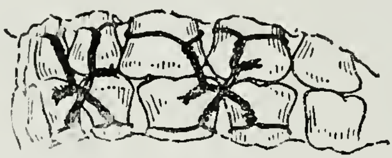


FIG. 92.— Gilmer's method of wiring lower to upper jaw by wires around necks of teeth.

If the mandible alone is broken, the upper jaw may be used as a support or splint. To do this, place a mass of softened modelling compound between the teeth and drive the upper and lower jaw into it in the position of occlusion. The composition is then allowed to harden in position. This gives a very fair splinting of the broken lower bone. The chin may be supported with a cap of pasteboard, metal, or modelling compound held in position by a figure-of-eight bandage of occiput and chin. Another method is the use of one of the splints devised by Supplee, provided the patient can breathe well through the nostrils. Fixation of the upper and lower jaws by wire ligatures around apposing teeth of the two bones may also be serviceable until a better form of apparatus for steadying the broken mandible can

be obtained. Some of these methods may in fact be employed as a permanent means. They may also be used at times in steadying fractures of the upper jaw, though in these there is usually less displacement than in those of the more movable mandible. The soft parts may be brought together over the broken bones after the fracture has been reduced. They should not be sutured so closely as to interfere with drainage if there is a probability of infection becoming marked. Care should also be taken not to stitch the muscles and skin in so tight a manner as to tend to reproduce deformity at the seat of break. When large flaps of tissue have been torn from the bones stitches occasionally need relief of strain. This may be accomplished by molding plates of vulcanite to the forehead and cheeks, fixing these by straps around the head, and connecting with them

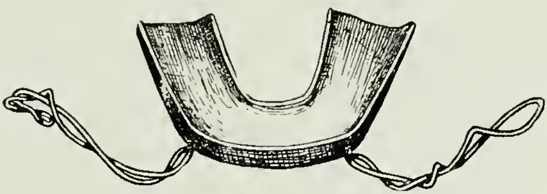


FIG. 93.— Impression tray converted into a Kingsley splint to be used with softened medeling composition in emergency treatment of injury to the upper or lower jaw. Pickerell has strongly advocated the use of such splints. *(From V. P Blair.)*

steel springs of heavy wire. To the ends of these springs are attached truss pads or fingers to press the detached soft parts into normal position. Tacks or staples may be employed to hold such accidental flaps against the bone, if sutures are not available.

Drainage will be particularly needed in damaged tissues of the lower facial region and chin. This should be provided for in some cases of fracture of the lower jaw by incision below the inferior margin of its body. Practically all fractures of importance in the alveolus and body are contaminated through the wounded gum with saliva and food products. Many such fractures will probably heal more promptly if, at the time of the original dressing or shortly afterwards, an incision is made below the inferior margin and drainage established. The gum is torn

at the time of injury because it is so closely adhered to the bone. Sometimes the extraction of a tooth may aid in permitting adequate drainage.

There occurs at times great swelling from laceration of the tongue or infection of that organ and the other tissues within the mouth. This complication may require that the breathing of the patient be provided for by a laryngotomy. Possibly a tracheotomy at some distance below the larynx may even be demanded. If the attachment of the tongue to the symphysis of the mandible is severed by reason of the operation or the complicated character of the fracture, the patient may become asphyxiated by the tongue falling backward and closing the opening of the glottis by pushing the epiglottis downward and backward. To avoid this catastrophe the swollen tongue may need multiple incision to lessen its bulk. It sometimes is wise after an operation under anaesthesia to put a long string through the end of the tongue, knot it at the ends and leave a hemostatic forceps attached to it. This instrument by its weight holds the tongue forward, and can readily be seized by the patient himself or nurse to re-establish breathing when the tongue has fallen dangerously backward. This string with the attached forceps may be removed at the end of twenty-four hours.

CHAPTER XIII.

GUNSHOT FRACTURES OF THE MANDIBLE.

Gunshot wounds of the lower jaw furnish very variable and many complicated fractures of that piece of the human skeleton. Blows received from slowly moving heavy projectiles may cause breaks practically indistinguishable from those seen in civil prac-

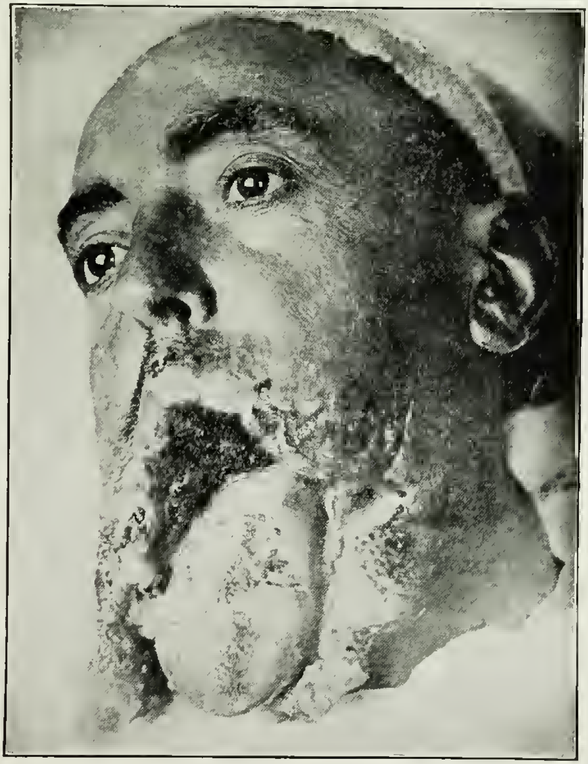


Fig. 94.— Large portion of lip, mandible and chin shot away by shell. (*Collection of Dr. H. W Scarlett.*)

tice. Small, rapidly moving bullets may simply bore a hole through one or both sides of the mandible, traversing the enveloping soft tissues with little damage. Large pieces of the body or either ramus of the mandible may be carried away or the frag-

ments driven into the mouth, pharynx, or the soft structures of the face. The structures composing the chin, including even the whole of the body of the mandible, may be carried away by the projectile. Such a wound or fracture permits the tongue and the ragged remains of the floor of the mouth to hang downwards through the gap.

Fig. 95.—After a series of operations on the soft parts and control of the mandibular fragments, a dental splint was attached to the teeth of the mandible and external submental support arranged. The internal and external supports were fastened together and downward drainage used. Later condition of patient. (See Fig. 94.)

In addition to the comparatively inconsequential injuries, multiple and comminuted fractures occur from pieces of shell casing and from shrapnel; from secondary projectiles thrown into the face, and from blows with rifle butt, sword or bayonet.

Although most fractures in the dental arch communicate with the mouth by breaks in the closely adherent gums, the fracture does not usually become infected. This rule does not hold good, however, if the fracture is comminuted or the mouth allowed to continue fetid during this treatment.

Approximation of the fragments in fractures with considerable loss of bone may be permitted in unilateral fracture near the angle. The swinging forward of the posterior fragment does not cause much loss of dental occlusion and the change in the articulation of the teeth of the two jaws causes slight defect in normal contour of the face. The lessened prominence of the angle of the mandible on the injured side is not great. Extraction of an upper molar tooth may be justifiable to encourage this forward movement of the posterior fragment of the damaged lower jaw. Fracture in front of the molars usually shortens the alveolar arch by such displacement; and preservation of correct dental occlusion is generally demanded from the beginning of treatment.

Infection in gunshot fractures of the lower jaw is to be expected; but although it is constant, it is less to be dreaded in respect to severity than the infectious processes which are common in similar open fractures of the limbs. Gas gangrene is not found in the oral injuries. The injured tissues have better metabolic defenses, drainage is more readily and more generally established, and the flow of saliva probably has an influence in washing away infectious fluids. The difficulty in maintaining a dry wound because of the presence of oral secretions is perhaps thereby somewhat counteracted by the irrigating influence of the salivary discharge. Submental incisions to insure drainage by gravity is a valuable expedient. The very radical removal of damaged tissues by excision, so necessary in infected war wounds of the trunk and limbs, is not so essential in facial and oral trauma. A toilet to cleanse the wound and to remove foreign bodies or splinters of bone is demanded, but it need not be so thorough as in gunshot injuries of other regions.

Aids to satisfactory respiration and alimentation may be needed. For this reason traction sutures to keep the tongue from falling backward are occasionally used, tracheotomy may become urgently demanded because of intraoral or intralaryngeal swelling, and ligation of lingual or other arteries may test the sur-

geon's efficiency as a dealer with secondary bleeding. A large catheter or tube of some sort may be utilized for feeding the patient with liquid nourishment.

If the tendency to displacement is persistent, wiring the fragments together, or fixing one or more teeth of the mandible against those of the upper jaw, by wires carried across from the teeth of the mandible to the teeth of the maxillae, may be a valuable expedient. Provision must be made for immediate release in the event of vomiting from anaesthesia or seasickness. Sometimes fixation by intraoral appliance or dental splint is necessary. Wiring the fragments in position may be done by passing a strong silver thread around several teeth on each side of the fracture and twisting the ends tightly with pliers. Rebellious fractures may require the ends of the bone to be drilled and wire sutures passed through the drill openings. This is not apt to be needed when the jaw is toothless or greatly atrophied near the point of fracture.

Dental splints are appliances worn inside the mouth and so fitted to the teeth and alveolus of the mandible that motion at the seat of fracture is prevented. A plastic impression of the teeth and alveolus is taken while the fragments are held in position; and from this a splint to fit the irregular outlines is made of rigid material. In making an inter-maxillary splint, a similar impression is taken also of the maxillae above. By means of impressions thus made in plaster of Paris a splint of metal or vulcanized rubbed is constructed with indentations into which the properly adjusted teeth properly fit. By applying such a dental or intermaxillary splint to the teeth, the bone is held continually in contact with it and mobility at the seat of fracture rendered impossible. This immobility is due to the crowns of the teeth being buried in the indentations on the surface of the splint. The simple dental splint fitting the teeth of the mandible alone and fastened to the alveolus may be sufficient. Instead of a dental splint, it may at times be better to construct a splint with indentations to hold the teeth of the upper jaw on one surface and the teeth of the lower jaw on the other surface. This is the intermaxillary splint. If a splint is made for the mandible alone it is fastened to the jaw usually by rods coming from it at the corners of the mouth and then attached to a splint beneath

the chin. This device is probably not as convenient and satis factory for preventing lateral movements as the inter-maxillary splint steadied by close contact with the upper as well as the lower teeth.

A temporary splint may be made by softening a gutta-percha strip in hot water, moulding it to the crowns of the lower teeth so as to overlap the adjacent gum and hardening it with cold water. Such a splint may be held in position by wires carried by means of needles through the muscles in the floor of the mouth and through the skin of the chin so that they may be twisted under the mandible over small rolls of plaster or pieces of cork. In subjects who have lost all or nearly all their teeth, interdental splints moulded to the atrophied gums present about the only efficient means of maintaining immobility. In all forms of splints greater immobility will as a rule be obtained by bandaging the jaws together. If desirable, gutta-percha wedges may be placed between the jaws on each side of the mouth in order to have a space in the middle for introduction of food. A crude form of intermaxillary splint may be made of cork cut to fit the teeth of the two jaws. An impression tray, such as is used by dentists in taking impressions for dentures, may be utilized as an emergency splint by putting softened modelling compound in its grooved surface and attaching wires to be thrust through soft parts and twisted under the mandible outside of the face.

Major V. P. Blair and his associates have devised a modification of the Gunning splint consisting of two trays, which are fastened together after each tray has been fixed in place. Its application is very simple and the splint may therefore be employed as a temporary fixation apparatus in emergencies. It is supplied as a standard splint to oral and dental surgeons in the United States Army.

Union of ordinary fracture of the mandible takes place in about five weeks, provided that sepsis does not occur and a fairly good apposition of fragments is maintained during the early stages. This statement, however, is subject to many qualifications, the most important of which is that a general surgeon without technical knowledge of the value of dental skill may obtain much poorer results alone than if he has the advice of an able dentist. The tray idea may be utilized to form an intramaxillary splint, if the surgeon will fasten two trays together by means of a

posterior hinge. Softened modelling compound placed in the gutter of each tray will allow impressions to be taken. When the compound has hardened the trays and their contents will be efficient as an emergency splint.

When there is a considerable loss of the bone at or near the symphysis, the two fragments will probably be drawn together by the muscles displacing the broken bone; this later will be increased by cicatricial contraction. Thus is given a narrow lower arch, and sometimes the contraction makes a V-shaped lower jaw. Such a deformity makes it impossible for the teeth in the mandible to have proper occlusion with those of the maxillae. The patient, therefore, is unable to properly masticate food. When the fracture is in the lateral portion of the body, the larger fragment is usually drawn toward the smaller which is situated on the fractured side. This causes deviation of the chin to the broken side.

The normal occlusion of the teeth should be re-established in gunshot fractures as soon as possible, even before there is any general suturing of stripped off soft tissues, if these are greatly lacerated. Unless this is accomplished, the fracture displacement will probably become permanent and reconstruction of the contour of the face very difficult to effect. When a portion of the bone is deficient as the result of fracture, the immediate treatment should be conducted in very much the same way that becomes necessary subsequent to excision of the mandible for tumor necrosis. The operative or accidental loss of a portion of the body of the bone requires that displacement should be prevented early by holding at once the pieces in normal position. This may be done by placing between the ends some plastic material which becomes hardened after its adaptation. The ends of the bone may also be held in position by heavy wires bridging the gap and attached to the teeth on opposite sides. The rigid wire used in this manner may, when there are no teeth for its attachment may be inserted in the inferior mandibular canal or passed through drill holes made through the sawed off ends of the bone.

Several forms of splint have been devised for this purpose. Bands or caps may be fitted or cemented to the teeth and a metal arch or a vulcanite substitute for the bone be introduced between the fragments. After a few weeks' wearing of the apparatus, the

displacing tendency may, perhaps, be overcome. Vulcanite prosthetic parts of the bone may be used to support plastic flaps, made from the two cheeks and the tissues of the submental region; and vulcanite plugs may be used to push the collapsed cheeks into proper position so as to remedy traumatic deformity. Temporary fixation is, therefore, to be always sought in war surgery as early as possible. A dental surgeon may be needed to properly make and supply the special forms of intraoral splint or apparatus needed to maintain adjustment of mandibular fragments in civil as well as military surgery. Torn off soft tissues may sometimes be held against the underlying bones of the face with tacks or small staples driven into the bone. The bones may be kept coapted at the seat of fracture by screws or fracture plates of steel or aluminum.

Major V P. Blair gives a valuable series of suggestions on the treatment of mandibular fractures due to gunshot and shrapnel injuries. These are epitomized in the next three pages:

RECENT FRACTURES OF THE MANDIBLE.

(1) **Fractures of the body of the mandible in front of the last existing tooth with no loss of bony substance.** This type may occur from concussion without the projectile striking the jaw. Fixation may be obtained by the usual methods of civil practice.

Hullihan's continuous dental splint and Gilmer's vulcanite lingual splint band wired to teeth are satisfactory in such cases.

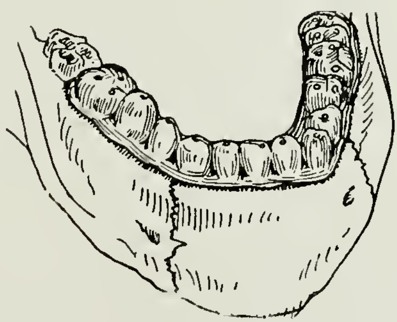


Fig. 96.— Hulihan continuous dental splint. (*After Angle.*)

(2) **Fractures of the body of the mandible in front of the last existing tooth with considerable displacement or considerable loss of substance and with few teeth remaining.** The majority of gunshot fractures, according to Blair, belong in this class. Fixation is to be secured in the two usual varieties as follows:

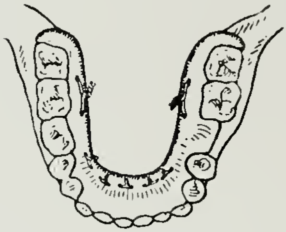


FIG. 97.— Gilmer posterior lingual band splint in place. (*From Blair.*)

(a) With loss of substance at the symphysis the tendency is for the fragments to be drawn together in front with the occlusal surfaces of the teeth facing each other.

(b) If the loss of substance is in the lateral portion of the bone, the fragment on the sound side is drawn over toward the affected side.

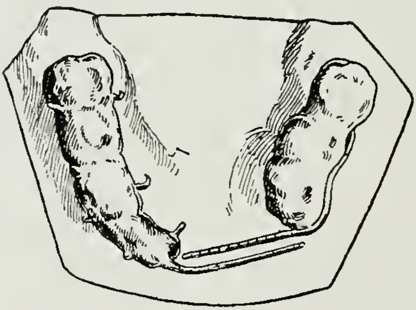


FIG. 98.— Sectional metal jacket and wire splint, showing the bridge made of two pieces of metal, the two halves to be put in separately and then the two pieces of the bridge bound together with fine wire. (*After Hayes.*)

In both instances, the fragments, which are separated by a gap due to the avulsed bone, are best held apart and fixed in normal relation to the upper teeth by the well known metal jacket and wire splint. This may be made in one solid piece, or it may be applied to the bone in sections, which are subsequently fastened together.

(c) When there is a tendency for the lower jaw to swing over to one side, on account of the loss of substance, the outer surface of the splint on the opposite side may be furnished with a metal flange to engage the teeth of the upper jaw. This acts as an inclined plane to throw the teeth into proper occlusion when the jaws are closed.

(3) **Fractures of the mandible behind the last existing tooth.** These fractures include those of the body of the bone, the ramus, and condyle.

(a) If no tendency to displacement is present and no loss of substance has occurred the simplest method of treatment is fixa-

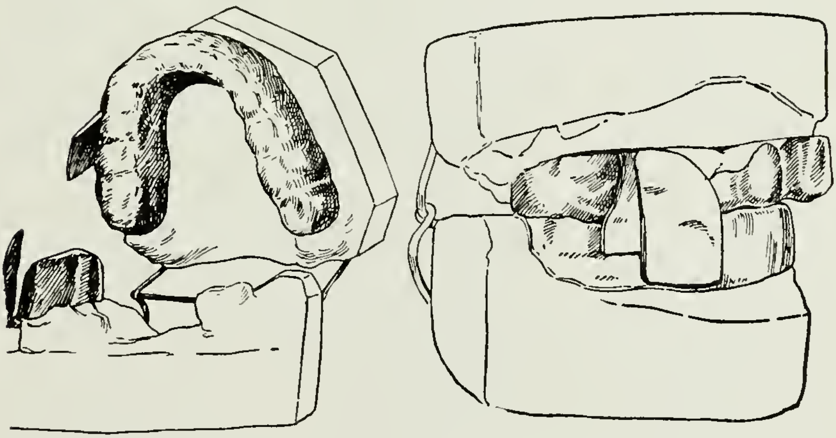


Fig. 99.—Metal jacket splints with inclined planes. The metal flange throws the teeth into proper occlusion when mouth is closed. (*After Hayes.*)

tion of the lower jaw to the upper with ligature wires directly applied to the teeth, or by the employment of Gilmer's posterior or lingual arch. Always provide for prompt release of the jaws to permit vomiting if the wounded man is liable to seasickness or vomiting from any cause.

(b) Fractures of the angle and ramus with loss of bone without displacement may be treated by wiring without splint.

(c) If the ramus is displaced either forward or laterally, the anterior fragment may be fixed by wiring the teeth to those of the upper jaw and the ramus steadied by means of an intraoral plastic splint of modelling composition. This is moulded within

the mouth. The ramus is drawn back with a hook introduced through the cheek or a lion-jaw forceps holding it through the skin. While it is thus supported the modelling compound is introduced, applied to the maxillae above and the ramus of the mandible and allowed to harden between the ramus itself and the last molars of the upper jaw, but continuing downward behind the mandibular molars. Remember the danger of a locked mouth in the event of vomiting during transportation or travel by sea.

(d) If no upper or lower teeth are available for wiring the jaws together, intermaxillary fixation with ligature wire may be applied. This is done by drilling holes through the two jaws at the level of the roots of the teeth on each side about three-quarters of an inch distant from the fracture line. Through these openings strong wire is carried and twisted so as to hold the fragments in coaptation. Other holes are drilled in the upper and lower jaws in the incisor region, or in other satisfactory sites, and wires for approximation and fixation are carried through the jaw bones so as to give firm contact to the bones. The fracture is then reduced and all the wires twisted to maintain the corrected position at the seat of fracture. Early release may be afforded by teaching the patient how to cut or untwist the ends of the wires in case of nausea or vomiting. Long ends to the wires or the habitual presence of strong scissors may thus save life from threatened suffocation with vomitus.

(e) Upper and lower swaged metal jackets may be found serviceable in the fractures under discussion. Sometimes the tendency to displacement in a lateral direction may be overcome by attaching to the splints hooks to which intermaxillary rubber bands may be fastened. If it is thought necessary to hold the jaw in fixation with the mouth open, in order to prevent forward displacement of the ramus, the Herpin splint seems available and likely to be useful.

Gunshot fractures of the mandible are so essentially open fractures in most cases that osteomyelitis and other septic complications are common. Necrosis may thus impede union and cause permanent non-union with atrophy of the ends of the fragments. A definitely false joint may result at the point of fracture. Violent primary hemorrhage may occur from the missile injuring the lingual, facial, or one of the carotid arteries. Secondary

bleeding may threaten the life of the patient. Septic oedema of the tongue, throat or glottis may give origin to dangerous dyspnoea. Unintelligent treatment or the character of the osseous injury may cause union to occur with great deformity of the mandible, malocclusion of the teeth or facial disfigurement from scar contraction. These sequels require active operative treatment on general surgical principles. Bone grafting from rib or tibia may enable the surgeon to reconstruct the mandibular arch; or he may use a piece of cartilage for this purpose.

The treatment of severe gunshot fractures of the mandible has received much attention by Trotter, Bennett, Morestin and

FIG. 100.— Fragments, after mandible was divided and part of body excised, held apart with stiff wire placed in mandibular canal by Dr. Schreiber. Bar to be removed later. (*Dr. Wm. L. Schreiber's Patient.*)

other members of the medical corps of the armies engaged in the European war. Their opinions are, as would be expected, somewhat at variance, but in the main they have become more and more alike as the continuation of warfare has given similar opportunity for observation to all the writers. There is evidence of a gradual standardizing of opinions and methods. I have tried to reach conclusions that may be considered as composite. Complications liable to occur early in gunshot fractures are hemorrhage from the floor of mouth and tongue, and cellulitis with sloughing. At about the end of a week, secondary bleeding as a result of the septic condition of the tissues is not unusual in

gunshot fractures of this bone. Chronic suppuration, burrowing abscesses, sinuses into the mouth and down into the neck, necrosis and consequent delay in union are to be expected, when the early treatment has been ineffectual. Delay in fixation of the broken bone or a riotous infection, or the two combined, may be the cause of the vicious or imperfect restoration of the mandible. Dental fixation of the fracture by appliances and procedures familar to oral and dental surgeons will usually obviate the indefinite prolongation of sepsis and lessen the probability of facial deformity from malocclusion and malunion.

Osteoplastic reconstitution of the lower jaw is attended with difficulty. The graft when placed in a scar, still septic, has a stormy career to meet. When there is a considerable part of the jawbone carried away by the projectile, immediate fixation of the fragments by coaptation is impossible, but to allow the ends of the main fragments to be drawn together by the displacing power of the attached muscles is obviously unwise. It can lead only to malocclusion of the teeth with its attendant imperfect mastication and alteration of the position of the chin. Utility and facial symmetry demand a better cure than that at the hands of the surgeon. In such cases the ends of the bone should be held apart by appliances devised by the dental expert until the muscles cease to displace the remaining portions of the mandible. Then a substitute for the missing section of bone must be supplied or bone grafting employed to fill the gap with living bone.

It is only allowable to sacrifice proper dental articulation for union of fragments when the resulting malocclusion of teeth will be slight. Surgery has outgrown the day when any sort of solid union was satisfactory after mandibular fracture. This applies to civilian as well as military practice.

The worst cases of gunshot fracture are those in which soft structures as well as portions of bone had been blown away. In these, not only bone grafting is utilized, but building up the chin and cheeks with cellulo-cutaneous flaps and skin grafts comes into play. The construction of large sections of the face out of metal, fitted to the underlying skeleton and tinted to resemble skin, may become necessary.

The astute surgeon must realize that in the severe injuries access to the parts, for the control of primary and secondary bleeding and for its prevention or abatement, must be uncompromisingly adequate. Free incisions of face, neck, and mouth must be made, when circumstances indicate such radical surgery. The facial structures lend themselves to plastic repair in an astonishing manner. The surgeon must know, however, the danger zones and fall back upon his acquaintance with vascular and nervous relations, and be competent to deal with asphyxia, hemorrhage and shock. This form of strenuous surgery brooks no delay, when excision of infected tissues is complicated with the necessity of a laryngotomy or tracheotomy, ligation of arterial trunks in the neck, and the administration of efficient amounts of anaesthetics. Major B. H. Ivy has well reviewed the recent literature on this subject in *The Military Surgeon* for May, 1918. I quote freely from his paper.

In dealing with severe injuries of the lower face and mandible, Trotter advocates laryngotomy before anaesthesia, or else intratracheal anaesthesia. After the fracture has been exposed by free incision or by turning back the soft parts from the middle line, in a manner to avoid paralysis of the lower lip, he removes loose fragments of bone and cuts away pulpefied or badly infected soft parts. A clean surface is given to the fractured ends of bone by a saw cut, and a large opening left for submental drainage.

The mandible may be ligated to the upper jaw by clamp bands and ligatures placed on firm teeth at each side of the fracture and connected by a bar. Instead of this method, a heavy wire bow, anchored by wire ligatures close to the teeth of the larger fragment, with traction on the smaller fragment accentuating the pull in the proper direction, may be employed.

This treatment is made continuous through the spring of the bow alone or by adding to the traction with rubber or silk ligatures on the teeth of the misplaced fragment. A simple wire bow is sometimes sufficient, when the fragments can be readily reduced; or an expansion arch may be ligated to appropriate teeth. This is particularly adapted in cases where the fracture is in front of the first molar, though greater stability is obtained by attaching a bow to each dental arch and ligating the upper to

the lower bow. Fractures of the angle or vertical ramus may be controlled by this method. Small hooks may be attached to the bows, thus giving opportunity for ligating them together or for producing traction by means of an elastic band. To the bows may be attached flanges or interlocking lugs in order to allow the mouth to be opened.

When there are no teeth in a small posterior fragment, a loop may be made at the end of the bow, covered with modelling compound and used to rest like a saddle on the fragment without teeth. Control of the posterior fragment may be secured when there is a gap in continuity of the body of the lower jaw behind the last available tooth by fastening a saddle to the end of the wire bow. A fragment which is drawn up may be pulled into a lower position, to conform with the plane of occlusion, by ligatures attached to the teeth and bow.

A transverse fracture of the upper jaw may require support from a head cap. This may be accomplished by fastening, to an upper extension arch, arms like those in the Kingsley splint for treating fractures of the maxilla. Continuous external pressure on the upper jaw may be obtained by attaching pads to an upper expansion arch through similar arms properly fixed to the arch.

When the median part of the lower jaw has been carried away by shot or shell, the ascending portions and angles keep their normal positions pretty well; but they do not meet the upper jaw at the same time when the patient shuts his mouth. In such cases, prosthetic aid for temporary or permanent use should be promptly afforded to enable the patient to escape difficult mastication and great facial disfigurement.

Elastic traction obtained by rubber bands attached to hooks upon maxillary and mandibular dental splints will be of great service in maintaining bony relations and dental articulation.

It occasionally happens in mandible fractures behind or in front of the angle that reduction of fragments is readily made without or with anaesthesia, but maintenance is at first difficult. Bridge splints, applied to the teeth, permit chewing and with a posterior saddle will hold the fragments in fair position. A few days later the saddle may be extended backwards and thus gradually by pressure recreate a proper relation of parts. This method is similar in its physiologic status to what the general

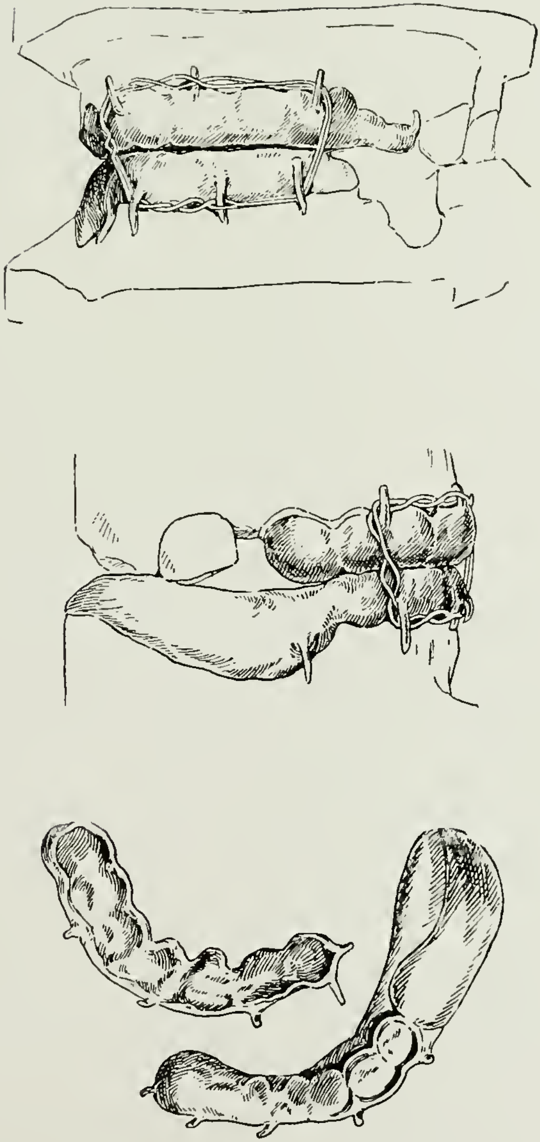


FIG. 101.—Swaged metal jacket splint with hooks and ligature wire.
(*From Blair, after Davenport.*)

surgeon does with pressure and traction apparatus in some fractures of the extremities. Relief of pain and absence of dread of pain lessen the muscular spasm, which causes displacement. The fragments, therefore, when the muscles assume their normal balance, lie nearly in normal relation and require only moderate fixation to obtain union in good position. Many surgeons fail to realize this truth.

A. Herpin, after experience with 906 fractures of the mandible,

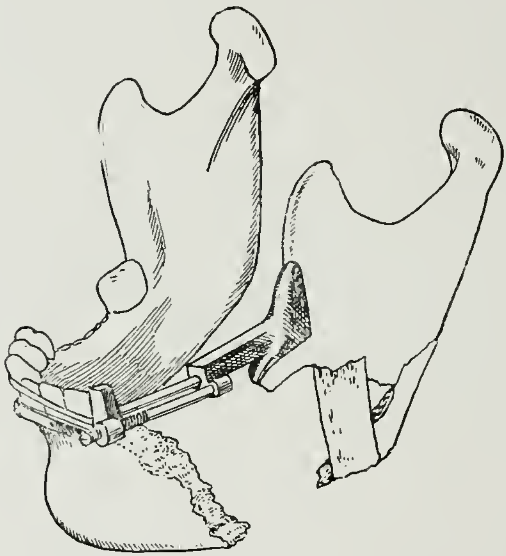


Fig. 102.— Bar and saddle splint. (*After Herpin.*)

gives one month as the average duration of treatment and a second month for convalescence. He believes bone grafts to be not indicated in recent fractures, which have been immediately immobilized with bridge apparatus securing accurate dental articulation and rapid reestablishment of function. He reserves bone grafts for old fractures which have failed to receive early and intelligent management. Herpin has seen 4½ cm. of new bone develop in fractures with loss of substance. It is slowly that such a large gap is completed. This patient was two and one-half months in obtaining consolidation. He states that with fixed bridge apparatus, which establishes mandibular functions

at an early moment, consolidation of fractures with gaps between the fragments may usually be expected. Development of bone in the interspace is most probable when the fracture has not occurred further back than behind the second molar. The formation of new bone proceeds from behind forward in reproduction of a mandible, because the anterior fragment has less nutritive supply. Early use of the jaw in mastication and speech encourages the blood supply and nutritive activity.

It is always necessary to establish the exact length of the mandible and to have the teeth fixed in normal articulation. The German surgeons as represented by H. Schroeder's statement hold the same opinion. This factor in success is likely, perhaps, to be overlooked in treating fractures of the ascending ramus and those near the angle. In these the posterior fragment is dragged upward while the anterior or horizontal piece goes backward; the dental arch is shortened, and the teeth, having their axis changed, point upwards and forwards. As a result the mouth does not open fully on the injured side, and later the teeth may become displaced and loosened by rarefying osteitis. Difficulty in mastication, painful teeth and possible non-union of the fracture may occur in these patients, if early fixation and correct occlusion of the teeth remaining after the gunshot injury are not obtained by the dental and surgical attendants.

The vulcanite saddle, which Herpin uses for these lesions of the vertical ramus, is attached to the bridge interdental splint. It holds the broken ramus parallel to that of the uninjured side. In difficult cases a piece is "installed on a slide with an excentric screw" to enable the dental surgeon to force backward the vertical piece and to bring forward and outward the horizontal piece. Consolidation in correct position is thus secured. I believe that Imbert and Réal are unwise in advocating close approximation of fragments in unilateral fractures of the mandible with loss of from two to three centimeters of bone and in recommending that dependence be placed on a change in movements at the joint to compensate for mal-occlusion of teeth.

Absence of teeth, for which artificial dentures may have been worn, atrophy or gunshot loss of alveolar margin of mandible, lack of dental skill, need of proper material or other emergency may make the application of inter-dental splints impossible.

Inter-maxillary lacing may then be used. A hole is to be drilled through both pieces of the mandible itself, at the level of the roots of the teeth, about three-quarter inch from the fracture line. A strong wire of silver, or other flexible metal, passed through these openings in the bone will allow the surgeon to coapt and fix the fragments by twisting the projecting ends of the wire. The readjusted mandible is then to be steadied by being wired against the upper jaw; this is done with two finer wires carried through holes drilled opposite each other in the upper and lower jaws in convenient places.

Submandibular splinting with a very strong rigid wire, bent to the normal curvature of the bone and extending from angle to angle, may be used in troublesome cases. Four steel screws are driven into the mandible upon its lower edge; two screws are placed on each side of the fracture at appropriate distances. The screws are introduced through four small incisions. The thick rigid wire splint is then applied outside the skin and tied with fine wire to the four screws, after reduction of the fracture ends. This method suggested by Pickerell appeals to the general surgeon as more efficient and less clumsy than the similar employ of a buried steel plate with screws. If preferred, one long incision may be made, on each side of the break, under and a little behind the thick lower border of the bone. The skin may then be slipped up so as to expose the front surface of the mandible, before the drill holes are made and the screws driven into the jaw. The stout wire submental splint might be buried under the skin and against the bone, instead of being applied on the outside of the skin. It could be readily removed after the fracture was solidly cured. A long incision beneath the jaw from angle to angle would leave an almost invisible scar by reason of being situated in a region usually in shadow. Pickerell says that slipping of the fine wire ligatures will be prevented, if the wire splint itself is notched where it is against the supporting screws.

An emergency open bite splint of the Gunning pattern, which is adjustable, is furnished in the U. S. Army Service at the suggestion of Major V. P. Blair, to make practicable early fixation in fractures of the jaw bones. Such early fixation relieves pain, exercises some control over the degree of sepsis, lessens hemorrhage, and has come to be a recognized axiom of fracture sur-

gery. It is not claimed that this splint will always bring the fragments into exact alignment, but it is believed to be of distinct value for temporary fixation. It is made on the Gunning model. The pillars of the two trays are to be turned down, and the splint bent to assume a form suitable to enter the mouth readily and engage the teeth of maxilla and mandible. The flexibility of the metal permits the trays to be compressed or expanded; and portions of the walls may be bent or trimmed away until a fair adjustment is made to the upper and lower dental arches. Both trays are then filled with modelling composition, made soft by warming over a flame or by being dipped in hot water until very soft. When the splint is placed in the mouth and the teeth of the uninjured, or less shattered, jaw have been pressed deeply into the modelling compound, the splint becomes rather firmly adjusted. The fragments of the injured jaw are then assembled in the best position possible, and the teeth of this arch are forced into the soft composition of the corresponding tray. A little care will enable the operator to use thus the sound or the less injured bone for a support to that which has been more seriously broken. Sometimes it will be necessary to remove the splint from the mouth and make a second trial for the purpose of perfecting the correspondence of splint and dental arches. When a fairly satisfactory reconstruction of the arches has been obtained, the still softened composition in the metal trays is pressed about the crowns of the teeth. Any external wound is then dressed.

A chin cup of modelling composition or an outside splint may be applied, if necessary for greater stability. A bandage over chin and cranium probably will be sufficient to maintain closure of the mouth upon the splint without a chin cup. The front ends of the two trays may be wired together, if this is thought desirable. In this event, however, provision should be made for quickly untwisting or cutting the wires, if vomiting occurs through sea-sickness or other cause. The open bite of the splint when wired would not be sufficient to prevent strangulation from failure to give exit to vomitus; though it is sufficient for feeding with liquid nourishment. This splint, though meant for temporary purposes, may often be sufficient for a more permanent intermaxillary splint.

Many fractures require external drainage by incisions along the lower edge of the mandible. It is often necessary in the immediate treatment of bad gunshot wounds of this region to lay open very freely by incision the muscular tissues, in order to readjust the fracture and gain the advantage of early fixation. Complicated secondary plastic operations would be less frequently required, if early reposition of bones with free incisions was routinely practiced. In this manner better understanding of the conditions would be obtained, contaminated tissues cut away, antiseptic applications given opportunity for action, and drainage, if necessary, established. Suturing in appropriate cases could also be done at the first dressing, and many of the complications of gunshot wounds of the face thus be avoided.

To remove the splint, it is only necessary to irrigate with warm water to make the composition soft, whereupon the splint may be gently loosened from the teeth; even the pillars may be bent to aid in its removal. An open bite splint should not be used as a permanent treatment in fractures of the mandible so far back that the posterior fragment will not engage in the splint. As a result of such practice malunion with open bite may occur.

When the adjustable open bite splint which has been described is not practicable, splints may be made from copper ferrules, if they are at hand in the dental outfits. The splint is made from them by conforming proper size ferrules to the teeth for anchorage. These should be trimmed and burnished not to extend beyond the masticating surfaces of the teeth. The opeartor then takes an impression in modelling compound with the ferrule on the teeth, and, when he removes the impression, the ferrules also are removed in position. If they are not so removed, they must be placed in the impression composition or plaster of Paris before the positive cast is made. After softening and removing the impression composition, the ferrules often will be found in their proper position on the teeth of the cast. The ferrules are later connected to one or two heavy wire arches with soft solder, thus constituting the necessary splint.

Major Robert H. Ivy has made an interesting review of Villain's writings on fractures behind the insertions of the elevator muscles of the mandible; that is, in the condyloid process. These fractures may or may not involve the temporo-mandibular

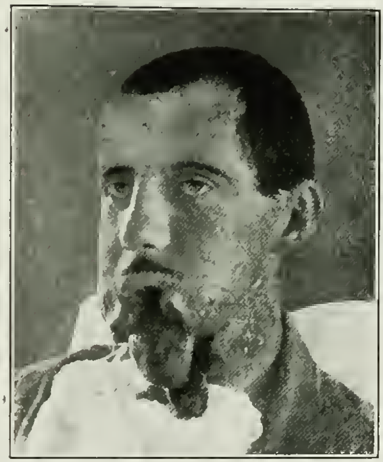


FIG. 103a.—First photograph. Front view.

FIG. 103b.—First photograph. Profile view.

FIG. 103c.—Second photograph. Front view.

Reconstruction of lower part of face and body of mandible after shell wound by Kazanjian and Burrows. (Early stages.)

Final Photograph.
Front view.

Final Photograph.
Profile view.

FIG. 103d and e.—Reconstruction of lower part of face and body of mandible, after shell wound, by vulcanite intra-oral support, plastic transfer and permanent prosthetic mandible. The plastic repair of chin and lower lip was done with large cheek flaps drawn towards middle line to meet a broad median flap from front of neck turned upward, with skin surfce inward. (*V. H. Kazanjian and H. Burrows, British Journal of Surgery, July,* 1918.)

articulation. The larger or anterior fragment is under the control of all the muscles of the jaw, except the external pterygoid, which is attached to the lower fragment in this post-elevator or condyloid region. I give here a summary of his review.

The symptoms of breaks vary with the extent of fracture and the amount of lost bone. Pain in the temporo-maxillary region on digital pressure and during mandibular movements especially during closure of the mouth, inability to protrude the jaw, disto-lateral displacement, tendency to vertical displacement, and oblique opening of the mouth toward the fractured side, are usually observable. Crepitus may also be detected by direct contact of the finger on the fracture, and when there is no loss of substance. There is very little swelling and induration of the skin if the fracture is closed or not infected; otherwise oedema and induration of the temporo-maxillary region are present. Trismus is established early and soon may develop into a stubborn contraction.

The small fragment is drawn by the external pterygoid muscle forward, inward and downward, whilst the injured end of the large fragment is drawn backward, outward and inward. The treatment of the post-levator fractures differs from that of other mandibular fractures in that the posterior fragment cannot be held by fixation apparatus; but this is not sufficient reason for entrusting repair entirely to nature or by merely fixing the lower to the upper jaw. Villain endeavors to gain not only maintenance of the large fragment in normal occlusion with the lower teeth, but also preservation of the correct contact of the fractured surfaces. He uses a splint attached to the upper and lower posterior teeth having a crank-like action and having a point of support which replaces the non-functioning joint. This apparatus varies somewhat with the direction of the fracture and the loss of substance.

Fractures of the mandible in the condylar region usually should be treated in "open bite" position, because observations of Cole and Bubb show that this obviates to a great extent the interference with motion liable to occur from scar contraction and obstructive callus. Fractures of the horizontal ramus are best managed with mouth closed with or without intraoral splints.

Fractures with marked comminution and serious displacement of small pieces of bone are always troublesome to the surgeon.

Extensive crushing of the jaw, with laceration of the soft tissues and wide displacement of splinters, with teeth lost either before or by reason of the injury, offers one of the most difficult problems in mandibular traumatisms. The same condition with preservation of a few teeth markedly displaced may be found. Horizontal fractures in combination with vertical fractures offer serious difficulty when reparative coaptation is sought in order to obtain firm union with good dental occlusion. Extensive crushing of the anterior portion of the jaw may have been caused by the shot or shell wound producing such displacement of fragments that consolidation is problematical, even when the quantity of bony tissue saved may be theoretically sufficient to permit it. Kazanjian has paid much attention to these complicated wounds of the lower jaw.

The displacement of the fragments is proportionate to the

destruction of the equilibrium of the muscles which move the jaw. The greater the injury, the more pronounced the displacement upward of the posterior parts and downward of the anterior fragments. In order for consolidation to occur in these cases, it is indispensable that all of the fragments be assembled in fairly good position and fixed there. The loss or absence of teeth is a serious obstacle, for it is clear that the small bone fragments themselves cannot be of great help in this fixation. Major Ivy has given an account of Dr. Kazanjian's views, which are in part as follows:

When the crushed portion corresponds to the incisors, canine and premolars, with displacement downward, the molars may be used for fixation of the splinters. A German silver bow-like arch may be fitted and cemented to the teeth in a manner to maintain satisfactory position of the two posterior segments. This arch should follow the curve of the bone at the height of the middle of the teeth. In its center is placed a T-shaped support, for the purpose of holding a vulcanite piece to replace the soft parts. Suture wires hold up against this arch the bony fragments at their normal height, reestablishing their normal points of contact. In case of a horizontal fracture of the mandible the inferior fragment is made to approach the other segment by a similar fixation device.

In similar cases, with absence of teeth on one side, bands of metal are fitted to the existing teeth, prolonged as far as the premolar region of the opposite side. They are cemented to the teeth and the suture wires placed as in the first case. If the lack of teeth has done away with the normal occlusion, a vulcanite piece is made for the upper jaw, to keep the fragment down in correct position against the solid lower portion of the mandible. An extra-oral plate may be constructed to act as an adjuvant to the immobilization by moulding a flat placque of vulcanite on the forehead, extending around to the temporal regions. This is then to be fastened to the maxillary arch with a rigid wire.

Cases in which the fracture reaches from one angle to the other, with extensive crushing, displacement and absence of teeth, constitute a third class.

These require slight modification to the scheme of immobiliza-

tion used in the first two types. Larger silver wires are fixed to the ends of the rami. An arch is fixed to them, upon which the bony fragments are suspended as heretofore. The upper teeth, when present, may serve for sustaining the apparatus; if not, recourse is had to an external appliance.

When the small fragments are to be sutured, the surgeon should give attention to this step as soon as possible after receipt of the wound, preferably within the first few days. All the sutures should be placed from within the mouth, and not through the cutaneous tissues. At first the fragments are denuded to allow the passage of the wires. Local anaesthesia is preferred, if possible, as it is less dangerous than general anaesthesia, which exposes the patient to the complications of broncho-pneumonia and renders the work of the operator more difficult. Contact of bony surfaces and reduction of the deformity due to the displacements are the important features. Absolute alignment is not always possible. The suture wire should remain for three or four weeks in order to secure solidification of the bony pieces.

A chin cup may be then employed as adjuvant, which would not have been possible at the first. The apparatus employed should give upward and forward pressure to counterbalance the action of the depressors. When cicatricial adhesion of the tissues tends to occur, a prosthetic piece is indicated.

A close-fitting skull cap made of muslin, with four hooks at appropriate sites for attachment of tapes, will be found superior to voluminous bandages over the cranium for holding in place moulded chin splints or intra-oral splints with protruding extension arms.

This method is only applicable in cases where there are extensive fractures of the jaw, lesions of the soft tissues, and total or partial absence of the teeth. There is no need to have recourse to it in cases less grave.

Even when complete consolidation is not obtained, the improvements which result justify the measure, because power of regeneration of the bone is very great; experience has shown that the probabilities of union are good when the fragments are replaced in good position and in contact. Even if union does not follow, future grafting operations are facilitated. By the rapid fixation of the fragments, the facial contour is notably preserved;

and future autoplastic operations, if needed afterwards, have been facilitated.

ANCIENT MANDIBULAR FRACTURES.

Old fractures of the mandible needing operative relief fall into two classes: Deformed union, following imperfectly reduced displacement of fragments or actual loss of bony substance, and non-union, more or less complete, usually due to initial loss of

FIG. 104.— Ununited fracture of mandible. Photographs before and after plastic operation in case of scars with ununited gunshot fracture of mandible. Later, a decalcified bone graft from tibia was used to obtain union. It was fixed in position with two plates and screws. Percival P. Cole in his Hunterian Lecture describes technic and believes in absolute fixation after grafting. (*British Journal of Surgery, July, 1918, from Percival P Cole.*)

substance from trauma or a secondary loss from infection necrosis.

When these conditions are marked, operation is the only remedy by which a relatively good dental occlusion, efficient mastication, and a relief from facial deformity, which is common, can be obtained. Resection of the seat of vicious or incomplete union is the first step; fixation in correct dental articulation, the

second, and often an osteoplastic reconstruction of the jawbone. the third procedure.

Matti of Switzerland prefers for the bone graft the crest of the ilium instead of the clavicle, rib, or tibia, which have been frequently used by other operators. His method includes local anaesthesia by nerve blocking and infiltration. He lays more stress upon accurate adaptation of the transplant and immediate restoration of the functional mobility of the mandible than upon a painstaking repair of periosteal covering, believing that periosteal vitality is of minor importance. Fixation of the mandible to steady the grafted bone is not adopted; but the patient is permitted to move the mandible at once. Pain and dread of pain will prevent a large range of movement in the early stages of convalescence. Solid fixation between implant and fragments tends, Matti believes, to produce atrophy of the repaired bone ends. Even infection, if not violent, may not prevent ultimate union. Matti reports 16 cases out of 21 bone graftings of the mandible which healed without reaction. In five cases suppuration occurred. At the time of his report three of these had resulted in solid union.

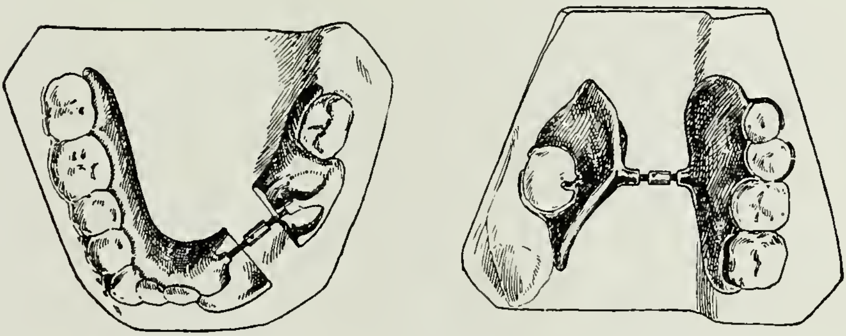


Fig. 105.— Sectional vulcanite splints with jack-screws for slow separation of fragments in old fractures or after resection of ends. (*After Hayes.*)

V. P. Blair's suggestions for ancient fractures of the mandible from war injury are as follows:

1. Operative treatment under local or general anaesthesia.

(a) Divide adhesions and callus, coapt the fragments by any

fixation appliance that meets the indications. The choice may be determined by the rules given above for recent fractures. Malunited fractures, after being cut apart as described, become practically new injuries and need similar methods of maintaining correct approximation. Occlusion of the maxillary and mandibular teeth should guide in the selection of the position before application of the fixation apparatus. Considerable gaps in the bone may be subsequently filled by new deposits of osseous material. Fragments removed by chisel or cutting forceps in clearing away the fibrous connections of the malformation and getting proper raw surfaces of bone may be used as grafts.

FIG. 106.— Excising jaw with Masland electric saw. (*Cadaver operation.*)

(b) Incomplete or non-union should be treated by excising the fibrous connections or the false joint and applying similar fixation apparatus to that employed in similar lines of fracture mentioned in the above paragraph. Inclined planes attached to the flanges to engage the teeth of the opposite jaw may be used to prevent the tendency to return to the incorrect position. Bone

or cartilage grafting will quite frequently be an available way of constructing a new section of bone.

(c) Separation of the divided tissues between the ends of the bone which has been operated upon may be maintained temporarily by softened modelling compound pressed into the wound for a few days, until grafting, with or without additional plastic operations, is undertaken.

2. Orthopaedic treatment.

(a) Moderate displacement may at times be corrected without open operation by the application of splints for the gradual restoration of the normal contour of the mandible. The prin-

FIG. 107.— Inserting rectangular bone graft from tibia into gap in madible. (*Cadaver operation.*)

ciples of dental orthopaedic surgery are the same as in surgery of other regions, but require modification at the hands of an orthodontic dental surgeon. Long periods of time are usually necessary for the gradual return of the displaced fragments of bone and the teeth to their normal site. Individual modifications will be required for the cases presented to the surgeon for reparative treatment. The common appliances are sectional bands, wire splints, jack screws, lugs and inclined planes so well described by Major V. P. Blair. Rubber dam or elastic webbing will often make comfortable and effective bandaging material for the head and chin. The figure-of-eight bandage of occiput and

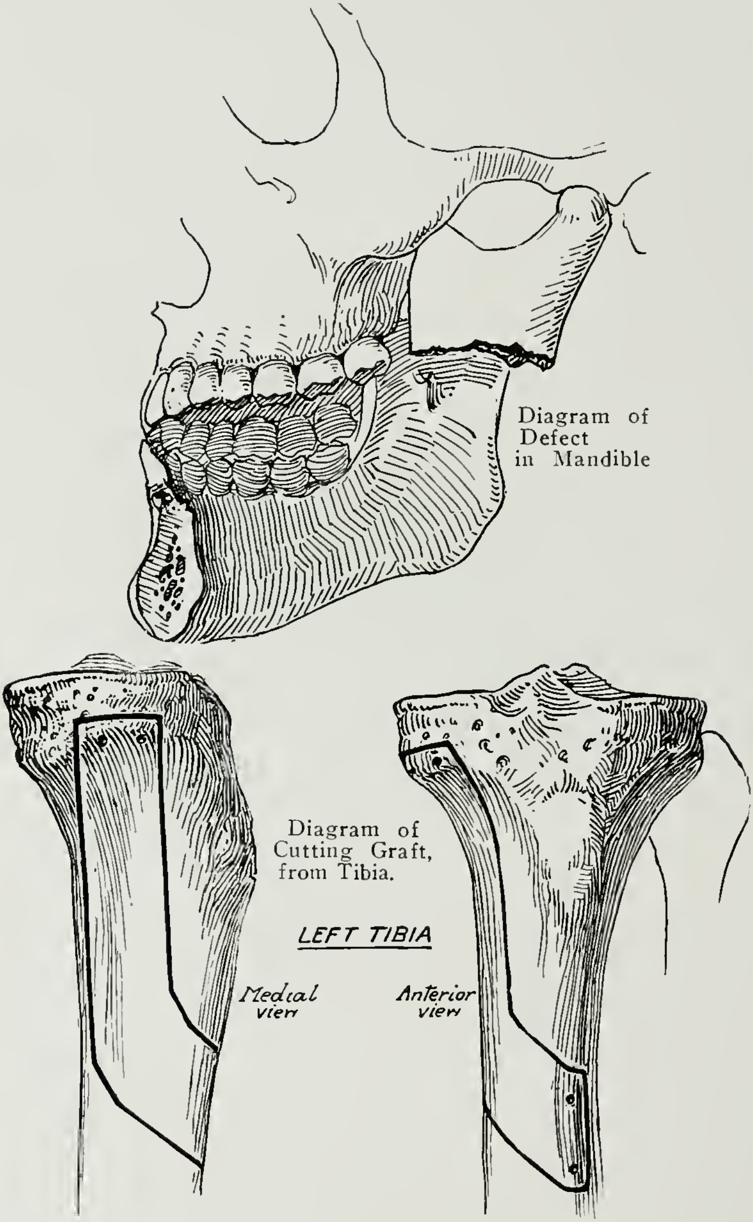


FIG. 108.— Outline of scheme for the utilization of bone from the upper end of the tibia in the repair of extensive defects of the mandible.
(*From D. B. Phemister in Surgical Clinics of Chicago.*)

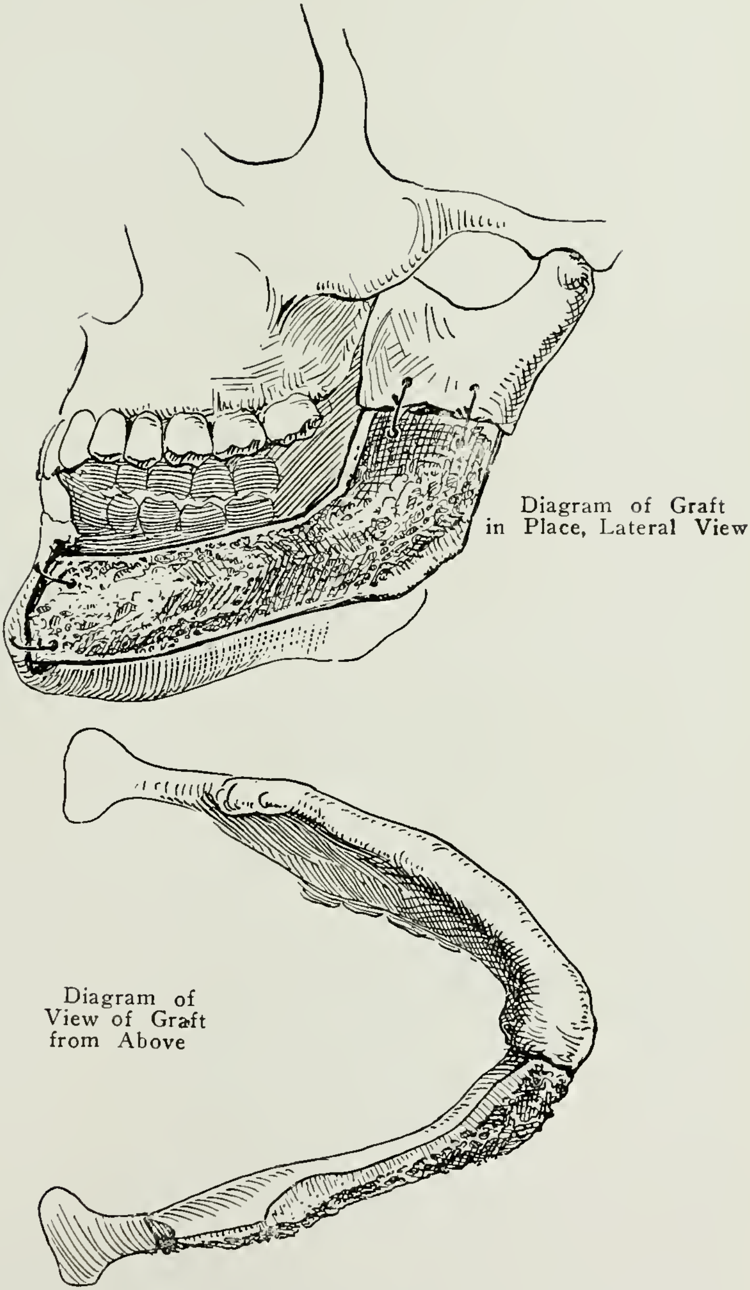


FIG. 109.— Outline of scheme for the utilization of bone from the upper end of the tibia in the repair of extensive defects of the mandible.
(From D. B. Phemister in Surgical Clinics of Chicago.)

chin is a valuable adjunct to the dressing of fractures of the jaw. If the form often called Barton occipito-mental bandage is employed, the horizontal turns will sometimes be more serviceable if carried around the front of the throat rather than the front of the chin. The latter method of making this portion of the dressing does not have a tendency to displace the mandible backward by the pressure in front.

Aseptic union in bone grafting operations on the jaw is always difficult to attain, and therefore special efforts are made to maintain the vitality of the transplant. Trotter endeavors to attain this object by using a bone graft with a muscular pedicle. He says that the part best adapted to such a purpose is the attachment of the sterno-mastoid to the inner end of the clavicle. The bone here closely resembles the mandible in texture, the upper half of it, with the broad attachment of the muscle itself, lends itself to detachment and to displacement into the gap of the jaw. Grafts may also be taken from unaffected portions of the jaw itself. Other operators use rib or costal cartilage, or strips from the tibia.

The surgeons should bear in mind that contact of the raw surfaces is of great importance in obtaining rapid union of the graft.

When not more than a half inch or a centimeter of bone has been lost, union may be expected without needing bone grafting. Greater extent of lost bone than about a centimeter and a half will probably require bone transplantation to obtain a solid mandible.

Some operators claim to have reconstructed by grafting even large portions of the horizontal ramus. They use cartilage or bone cut to resemble in shape even the angle and ascending ramus as well as the adjacent part of the horizontal body of the mandible. This they insert as a transplant.

Full face. Side face.

Fig. 110.—Gunshot wound of face, carrying away a large portion of the ramus and body of mandible. Reconstruction of cheek from dorsal and pectoral flaps was done. (*Author's patient.*)

Fig. 111.—Gunshot wound of face, carrying away a large portion of the ramus and body of mandible. Reconstruction of cheek from dorsal and pectoral flaps. Photograph after a series of operations show chin in median line and ability to open mouth. (*Author's patient.*)

CHAPTER XIV.

DISLOCATIONS OF THE MANDIBLE.

Relaxation of the temporo-maxillary ligaments and a shallow glenoid cavity in the temporal bone are predisposing causes of dislocation of the mandible. The exciting causes are muscular efforts or traumatic forces tending to separate the jaws very widely. This force upon the chin while the mouth is open and unusual muscular effort such as occurs in yawning, laughing and sneezing, may lead, therefore, to displacement of the condyloid process of the mandible. The dislocation may be on one or both sides; the bilateral displacement is probably the more frequent lesion.

The more common luxation is forward, although other dislocations occur. The last usually occur as complications of fracture, whereas the forward dislocation is likely to be unaccompanied by injury to the bone itself. The mechanism by which the forward displacement takes place is that the internal pterygoid muscles act as a fulcrum, while the muscles of the neck which are attached to the chin, or the blow received upon the front of the lower jaw, act upon the long arm of the lever. This force, in association with the external pterygoid pull, causes the condyle to tear its way through or stretch the capsular ligament in front of the joint. The condyle then rides upon or entirely over the articular eminence of the temporal bone. The masseter and temporal muscles then have opportunity to pull the condyle upward until the mandible is stopped by the zygomatic arch.

A tendency to habitual subluxation of the temporo-maxillary joint may be met with in persons with relaxed ligaments. This displacement gives a snapping sound during eating. Increase of muscular tone will probably prevent the continuation of this condition.

In addition to the forward and backward forms, an upward dislocation, it is said, may take place by a force applied to the chin while the mouth is open. It may also happen from an upward blow beneath the angle of the bone when the posterior teeth of both jaws are absent. The lesion in this case is similar to that which happens from great traumatism applied to the

thigh bone when its head is driven through the acetabulum. In the maxillary luxation under consideration, the condyle breaks through the bottom of the glenoid cavity and enters the cranium.

A case has been reported in which an outward dislocation with fracture occurred and the condyle was found outside of and above the zygoma, constituting an outward dislocation.

The symptoms of the forward dislocation consist in a widely

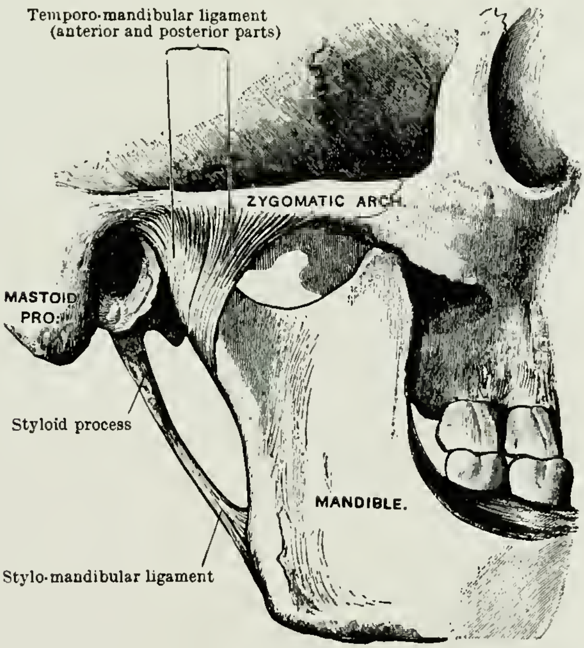


FIG. 112.— The temporo-mandibular joint, outer aspect. (*From Cunningham.*)

open mouth which the patient is unable to close. The mandible is immovable, a vacuity is noticeable in front of the ear, and the condyle felt beneath the zygomatic arch. In dislocation of one side only, the chin is thrown a little toward the uninjured side of the head. In bilateral dislocation the chin is forced forward. The patient complains of pain in both cases and the saliva is apt to escape from the mouth from want of its control within that cavity.

Reduction of the forward dislocation may often be accomplished without anaesthesia, if the surgeon understands the manipulations and acts promptly before the patient becomes afraid of his movements.

He inserts his two thumbs, wrapped with bandages to prevent injury from the teeth closing upon them, upon the last molar tooth of each side, grasping the body and ramus of the jaw with the palms and fingers. Pressure downward is made upon the teeth in order to unlock the condyles from their position in front of the articular eminences. After pressure downward, and perhaps to increase the opening of the mouth a little more, has been

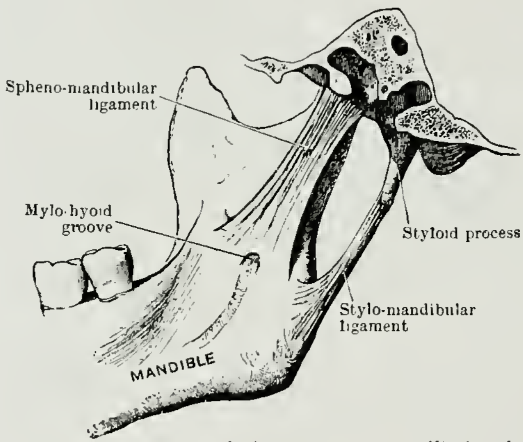


Fig. 113.— Inner aspect of the temporo-mandibular joint. (*From Cunningham.*)

made for a few moments, the chin is suddenly drawn forward and elevated a little. This manipulation has a tendency to lift the condyles over the articular eminences. The muscles cause them to snap back into their normal position.

There is a possibility of the fingers of the surgeon being bitten if they are not quickly withdrawn at the proper moment. A unilateral dislocation is reduced in a similar manner. A bandage, such as the occipito-mental figure-of-eight, is then applied to the cranium and chin to keep the mouth closed for a few days. In some subluxations the teeth are closed and the displacement is overcome by simply forcing the teeth apart. In unreduced dis-

locations a certain amount of mobility of the jaw is likely to be finally obtained, but a complete closure of the mouth is improbable. If reduction cannot be obtained, excision of the condyles or the establishment of a false joint by osteotomy may give good result.

Treatment of the rare upward dislocation might require trephining above the glenoid fossa to permit extraction of the condyle from the cranial cavity and to treat the complicating injury of the intracranial structures. Fragments of bone should be removed from the brain if driven into it; and the middle cerebral fossa might require drainage. Appropriate dental fixation would be demanded. Blair reports a partial upward dis-

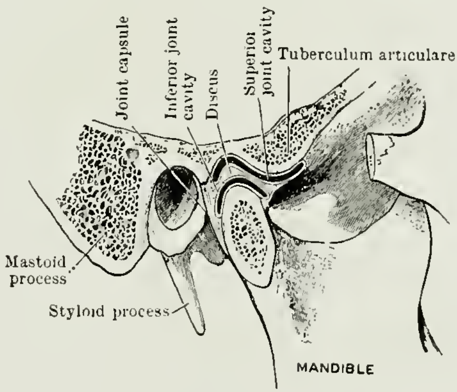


FIG. 114.— Section showing anatomy of temporo-mandibular joint. (*From Cunningham.*)

location kept in position by wiring the maxilla and mandible together for five weeks. The outward dislocation would probably be reduced by thrusting the ramus outward to disentangle the condyle from the zygoma and then by pressure replacing it in the socket.

The treatment of complicating fractures should be carried out on the usually approved plan after reduction of a dislocation.

It will be readily understood that a severe backward blow on the chin, such as might occur in civil as well as military practice, could cause the condyle to be thrust against the posterior wall of the glenoid depression so as to drive it into the external audi-

tory canal. The chin would, therefore, be displaced backward and the condyle found by x-ray or other examination to be in an abnormal position.

Replacement and retention of the jaw with the teeth in proper occlusion are indicated as treatment.

When reduction of these various dislocations has been accomplished recurrence must be prevented by appropriate bandaging. The occipito-mental bandage, with or without the chin cap, will usually be found sufficient when there is no accompanying fracture; otherwise, interdental fixation by wires or splints will probably be required.

ANCIENT DISLOCATIONS.

It is said that an unreduced anterior dislocation is not always as serious a handicap to the patient as might seem probable. Reduction, however, should be attempted. If unsuccessful, it should be followed, if symptoms are conspicuously unsatisfactory, by opening the joint and replacing the condyles. Unless the dislocation is one of years' standing, this operative treatment should probably be attempted on all occasions, if the patient will allow it and the surgeon has proper aseptic facilities. Excision of the condyles may become necessary, which operation is likely to result in good function.

Recurrent luxation should be treated by limiting motion for a number of months, or by exposing the joint and reducing the relaxed capsular ligaments by excision of a portion of the structures. If an opening still exists at the point where the condyle escaped from the capsular ligament, suturing without removal of a section of the ligament may be sufficient. If the cartilaginous meniscus within the joint has suffered fracture, crumpling, or displacement, like lesions which occur in the knee joint, arthrotomy with suture or removal of the intraarticular cartilage should be performed.

ANKYLOSIS OF TEMPORO-MADIBULAR JOINT.

Ankylosis of the mandible, when treated by screw gags or distending apparatus, should not be twisted by them in an oblique direction. The force is better used when applied upon the two

dental arches by means of appropriately fitting plates resting on the teeth. To these may be adapted extensions with jack-screw attachments when gradually increasing force is needed.

Cicatricial trismus may be overcome by gradual stretching of the scar tissue, provided the condition is not extensive or serious. This method of treatment may require aid from surgical incisions to detach soft parts from the bones. While the patient is still anaesthetized a vulcanite splint may be adjusted to the teeth. This should be shaped to fill out the spaces formerly obliterated by the contraction. In order to keep the parted structures from coming together again, modeling composition may be pressed at once into the new cavities. A few hours later the splint constructed to fully confirm with the newly made oral cavity is to be inserted. Stretching and massage will aid in this gradual mechanical treatment. The serious cases require more extensive operative surgery, and a combination of mechanical and operative management will often be necessary to obtain satisfactory mobility.

TRISMUS.

Wounds in the temporal region may cause union of coronoid process and zygoma to each other or to base of skull, requiring osteotomy with plastic reconstruction of the muscular surroundings. Ankylosis of the temporo-mandibular joint arising from arthritis due to gunshot may require arthroplasty. Suppuration and cicatricial dragging may cause contraction of masseter and pterygoid muscles interfering so much with chewing and vocal perfection as to demand operation. Punctured wounds sometimes lead to a similar disability from a tonic spasm of muscles due to nerve irritation. Impacted teeth which have never erupted may lead to tonic spasm with consequent trismus, and hysteria may give rise to a similar inability to open the mouth.

An x-ray examination may be needed to clear up the diagnosis in such cases. Its findings may be proved or disapproved by general anaesthesia, which induces complete relaxation of the stiffened muscles in hysteria and mere muscular spasm. Locked jaws from articular ankylosis will remain immobile.

Stretching the muscles with wedges between the teeth, urging frequent motion of the jaws as in chewing sweetened gum, local massage and general treatment for mental and nervous loss of tone, are the indicated remedies in cases of spasm. The ordinary spring clothes-pin, for holding the washerwoman's articles on the line to dry, makes an excellent spring for the patient to thrust between the teeth of the stiffened jaws.

Inability to open the mouth from one-sided or bilateral lesions at the mandibular joint, due to unreduced old dislocations, fractures with displacement and intraarticular adhesions, require operative relief. The character of the surgical intervention varies with the organic mechanical cause. Fracture of the zygomatic arch with inward displacement of the fragments may prevent the coronoid process sliding under the arch. This condition must not be overlooked as a cause of interference with movements of the lower jaw.

Trismus following injuries in war may be due to:

1. Bony ankylosis of the temporo-maxillary joint, requiring resection or arthroplasty.

2. Wounds of the coronoid process and temporal muscle; bony connection by new bone between the coronoid process and the zygoma or base of the skull. These require osteotomy or exsection.

3. Chronic inflammatory alterations with contraction of the masseter or pterygoid muscles from long continued suppuration. The use of gags under anaesthesia and persistent stretching subsequently are lines of treatment to be followed, though operation may be necessary.

4. Tonic spasm of the muscles of mastication by chronic irritants such as infected teeth may arise from wounds in the mandibular region. Hysterical conditions may cause similar spasm of the masseter and other muscles.

Trismus is, of course, an early symptom of infection with the tetanus bacillus, and has been thought of whenever the patient has difficulty in opening the mouth. In time of war patients wounded and subjected to contact with the earth should be given, if possible, tetanus antitoxin.

CHAPTER XV.

INJURIES OF THE TEETH.

Direct blows may fracture the teeth or loosen their connection with the alveolus. Injury may occur to the tooth pulp, so as to cause its death with subsequent conversion of the tooth into a dead structure. The line of fracture of maxilla or mandible may devitalize the tooth pulp or actually loosen the tooth itself. Loosened teeth may be expected to become again firmly attached to the alveolar socket unless they are situated within the line of fracture. Then they should, as a rule, be removed at the time the fragments are reduced and the fracture fixed by the coapting appliance. Displaced teeth still keeping an attachment to the socket should be replaced and steadied by ligatures, wire or bandage to adjacent teeth. Firm adherence may be expected.

Gunshot and similar injuries may tear teeth entirely from their bed in the bone. Under favorable conditions such a tooth may be replanted in the alveolus and successful attachment be obtained. The operator must wash the tooth in sterile salt solution, clean, sterilize and fill the root canal, after cutting off a small portion of the apex of the tooth, and then force the tooth firmly into the already cleansed and sterilized socket. The avulsed tooth after its replantation should be steadied with wires, ligatures or dental splint until it becomes firmly reattached to the socket.

Transplantation of foreign teeth may be successfully accomplished by a similar procedure. The tooth from another region of the same mouth or from another person is replanted in the bony socket, as described in avulsion of a tooth from its own bed in the alveolus. It is even possible to bore a deep pit in the maxillar or mandibular alveolus and implant a sterile tooth into this artificial socket. Such operations in the mouth are similar in their physiological principles to the insertion of foreign bodies in the soft tissues for holding fractured bones in apposition, or to close openings. The cellular activity of the tissues surrounding the implanted body encysts it by creating a connective tissue envelope about it. Teeth for implanting or transplanting should

be sterile or relatively so; but should not be subjected to boiling, although metal objects may be sterilized by boiling before insertion for permanent retention. The cleansing solution for sterilizing teeth should be the mildest sort of antiseptic or better, perhaps, only an aseptic normal salt solution. The periosteum and pericementum of the bone and tooth should be as little disturbed as possible.

Great cleanliness of the mouth should be maintained until the tooth for which a solid attachment is sought has become firmly united to the alveolus.

TRENCH MOUTH.

The oral affection, to which the term trench mouth has been applied, is, according to McKinistry, identical with Vincent's angina of the gums. The tenderness about the teeth due to the infection may be great and the inflammation severe. It is associated with the presence of fusiform bacilli and is contagious. A soft tooth brush to remove particles of food, frequent and thorough cleansing with alkaline mouth washes and efficient scaling of the teeth and gums to get rid of tartar and other deposits, are proper prophylactic and curative measures. Extraction of teeth is probably never necessary. McKinistry recommends cleaning every crevice of the gums, drying with cotton, and then swabbing with alkaline salvarsan solution double the strength employed for intravenous medication in syphilis. This application should be used once or twice daily until the affection is controlled.

FRACTURE OF THE LINGUAL OR HYOID BONE.

The usual fracture of this bone occurs near the point where the great horn joins the body. It is not a common injury, because the buried position of the bone shields it from receipt of both direct or indirect blows. Its mobility and elasticity render it less likely to give way under violence. Fracture of the hyoid bone is at times associated with fracture of the laryngeal cartilages and is due to similar causes, namely, pressure of the rope in hanging, grasping the throat by the fingers as in homicidal assaults, and direct blows upon the bone.

The symptoms of hyoid fracture are sharp pain, increased by pressure, speaking, swallowing or protruding the tongue, swell-

ing, displacement and motion of the fragments and crepitus. If the mucous membrance of the pharynx has been perforated blood will appear in the mouth. Sometimes the surgeon's finger in the pharynx will detect the displacement with ease. Coughing with paroxysms of choking or asphyxia may follow attempts at swallowing food or protruding the tongue. The treatment consists in replacing the fragments, possibly with one finger in pharynx; keeping the parts quiet by prohibiting talking and by feeding the patient on liquids by means of a tube. Dyspnoea may necessitate a tracheotomy.

A collar-like band of adhesive plaster around the neck close under the mandible may possibly aid in retaining apposition of the fragments. It is possible that excision of the broken-off end or suture with catgut might be of service in cases with severe symptoms.

FRACTURE OF THE CARTILAGES OF THE LARYNX AND TRACHEA.

The exposed position of the larynx makes it more subject to fracture than the hyoid bone. Laryngeal fractures are at the same time more dangerous, because the intralaryngeal swelling is very liable to cause fatal asphyxia. Blows, falls, hanging, homicidal throttling and pressure backward against the vertebral column are the causes likely to produce such fracture. The mucous membrane is frequently torn, leading to extravasation of blood within the larynx and emphysema of the cellular tissue of the throat and neighboring regions. The upper horn of the thyroid cartilage is sometimes developed as a sort of epiphysis. Epiphyseal separation may then occur.

The symptoms are deformity, motion and crepitation, accompanied by convulsive cough, alteration or loss of voice, dyspnoea, painful deglutition, and in many instances frothy, bloody expectoration. The emphysema that is seen in many cases may spread over a large portion of the neck, face and trunk.

In severe fractures death is common from suffocation due to subcutaneous hemorrhage, to free bleeding into the larynx or to inflammatory or emphysematous swelling. The fatal issue may suddenly occur several days after the receipt of injury. Repair occurs most probably by osseo-cartilaginous material.

The treatment consists in remedies to allay inflammation, and cautionary tracheotomy, lest fatal obstructive swelling occur

unexpectedly in the larynx. Anodynes to relieve coughing may be wise. The opening made by tracheotomy may be of value in giving the surgeon an opportunity to replace the broken fragments by the introduction of instruments into the air passages. It is unwise to postpone tracheotomy until dyspnoea becomes extreme, since asphyxia may be sudden. The operation had better be done in all cases of severe fracture before the patient is left by the surgeon. A permanent tracheal opening is sometimes demanded after fracture of the larynx.

The tracheal rings occasionally sustain fracture. The diagnosis is often difficult, but if such injury is discovered it should be treated as fracture of the larynx by antiphlogistic measures and tracheotomy below the seat of injury. The tube introduced should extend below the broken cartilage.

LARYNGOTOMY AND TRACHEOTOMY.

In cases requiring rapid laryngotomy or tracheotomy etherization may be dispensed with; the painful part of the operation in cutting the skin may be avoided by freezing with ethylchloride spray, or by pressing a lump of ice sprinkled with salt over the region to be incised. Infiltration anaesthesia by cocain, or novocain may also be used. In instances of imminent suffocation from prolonged obstruction of the larynx the sense of pain is practically absent. In such patients the crico-thyroid membrane may be quickly opened with a pocket knife; or, after a puncture of the skin, a trocar and canula may be thrust through the intervening tissues and through the crico-thyroid membrane into the larynx and trachea. When a formal laryngotomy or tracheotomy is to be performed the head should be drawn back so as to put the neck on a stretch. A median incision is then to be made from the thyroid cartilage downwards, or from a lower point if tracheotomy below the isthmus of the thyroid is contemplated. The length of the incision depends upon the thickness of the neck and the consequent depth at which the trachea is situated. If merely a laryngotomy or laryngotracheotomy is to be made the finger of the operator can usually locate the thyroid cartilage by its prominence, and feel the situation of the depression between the thyroid and cricoid cartilages.

If asphyxia is imminent the veins will be turgid and liable to be cut. They usually stop bleeding as soon as respiration is reestablished by opening the windpipe. The patient, however, must

not be allowed to inspire the blood. Therefore, the bleeding should be stopped or the patient held by asistants, so as to be quickly turned on the face to allow the blood to flow out of the wound as soon as the opening has been made in the air passages. The section is continued in the middle line through the deep fascia and between the sterno-hyoid muscles until the isthmus of the thyroid gland is exposed. This structure should be pushed downward or drawn upward according as the surgeon expects to open the trachea in the upper or lower part. When laryngotomy is to be done the structures to be opened are almost subcutaneous. It requires, therefore, more skill to do tracheotomy below the situation of the larynx. Should the isthmus of the thyroid gland be not easily displaced a ligature should be tied around it on each side in order to prevent hemorrhage before it is divided between these ligatures.

The trachea is recognizable by its white color when the tissues over it in the middle line have been incised and the muscles retracted by small retractors or forceps. A tenanculum hooked into the anterior wall to steady it aids greatly when the surgeon plunges a sharp-pointed bistoury into the windpipe. Two or three of its rings are divided in an upward direction. When the bleeding has not been arrested before the trachea is reached, incision should not be made, unless great haste is demanded, until the bleeding has been controlled by ligatures or hemostatic forceps. When urgency requires haste the patient should be turned upon his face with his head over the edge of the table and retained in this posture while the tracheal incision is made. This averts the danger of inspiration of blood and possible suffocation. As soon as the rings have been divided it is well to thrust a pair of forceps or some dilating instrument into the windpipe in order to hold the lips apart. In this manner a supply of air is at once given to the patient and blood and mucus which may be obstructing the air passages are coughed out by the patient's efforts. After the trachea has been cleared a tracheal tube may be inserted and retained in order that respiration may go on without obstruction from falling together of the lips of the wound. One of the best forms of tracheal tubes consists of a double canula, the inner one of which projects at the internal end a little beyond the outer one. The object in having two tubes is to enable the attendant to remove and clean the inner tube as it becomes blocked with mucus or dried secretion while he leaves the

outer one in the wound in order to replace the inner tube readily. The outer tube is usually provided with flanges upon the side by which it is held in place by tapes tied around the neck, or by sutures carried through the adjacent skin with a needle. One of the best forms of tracheal tubes that I have ever seen is the so-called double lobster tailed tracheal canula of the late Mr. Durham of Guy's Hospital, London. It is provided with a movable shield to regulate the depth of the inner end from the surface to provide for its use in thick as well as thin necks. It is inserted by a lobster tailed stylet. This is removed as soon as the tube is in place and the inner canula inserted.

A good many years ago tracheotomy was frequently done for diphtheria. Before the employment of intubation by O'Dwyer's method I was in the habit of cutting out a portion of the tracheal rings instead of relying upon the incision. I think this is in urgent cases of difficult breathing, from obstruction of the larynx, an improvement over the mere slit for the canula. In threatening cases of asphyxia in war wounds of the face requiring tracheotomy the subsequent care of the patient may be lessened by stitching the edges of the trachea to the skin and using no tube. This may be available particularly when transportation prevents continuous and careful nursing. A piece of drainage tube may be used instead of a tracheal catheter when the latter is not to be obtained. If the patient has stopped breathing before the surgeon has gained an entrance to the windpipe, artificial respiration may be started by blowing into the tube with a large syringe, or a pair of bellows, or by the operator's lips.

In cases of chronic stenosis of the larynx, in which the tracheal tube must be constantly worn, a tube with an opening in the intratracheal portion is used to enable the patient to expire through the larynx. This enables him to talk with comparative ease, which is impossible with a tube fitting the trachea tightly and allowing no air to go through the glottis. Instead of tracheotomy or laryngotomy, intubation of the larynx may at times be available during operative work on wounded men. This may be done in a similar manner to that which is used in the O'Dwyer method of intubation for diphtheritic obstruction, or by manipulations similar to those employed in intratracheal anaesthesia.

III. RECONSTRUCTIVE TREATMENT OF WAR INJURIES OF FACE.

CHAPTER XVI.

THE PRINCIPLES OF PLASTIC REPAIR OF WOUNDS.

The principles and objects of plastic or reparative surgery of the face may be most readily grasped by a brief syllabus of its characteristics. It is after all only an application of the truths of surgery in general.

Nature:

Simply a part of General Surgery.

Must study metabolism, infection and repair.

Objects:

1. Construction of absent or lost parts.
2. Reposition or curtailment of parts displaced or deformed by injury or disease.

Nomenclature:

Greek word, plasty (= made), used as suffix.

Examples: 1. rhino-plasty, stomato-plasty, blepharo-plasty.
2. auto-plasty, hetero-plasty.
3. osteo-plasty.

Uses:

To correct deformity,

1. From imperfect foetal development, as in harelip, absence of parts of nose or ear;
2. From injury causing ablation, as in war wounds or operations;
3. From ulceration or mortification, as in salivary fistules and gangrene of lips;
4. From cicatricial contraction, as after burns;
5. From overgrowth or irregular contour, as in gigantic nose or flaring ears.

Structures used:

Skin, subcutaneous fascia, mucous membrane, adipose tissue, deep fascia, muscle, nerves.

Cartilage, periosteum, bone.

Character of patient and tissues:

1. In good health,
   Syphilis excluded or cured,
   Rickets cured,
   Hemophilia treated.
2. Aseptic tissues.

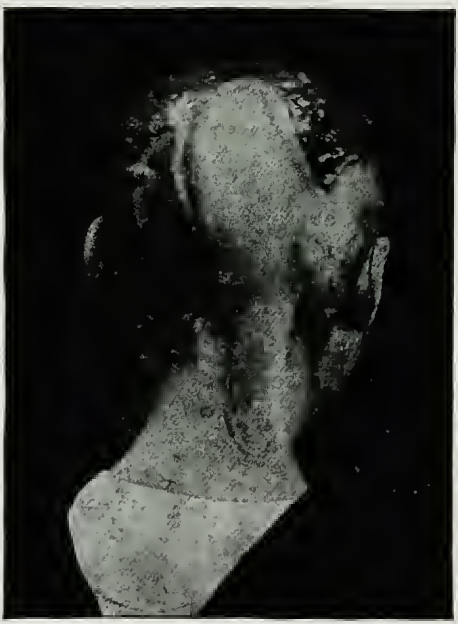


Fig. 115.— A swing flap fastened to cranium with carpet tacks. (*Keen's Surgery.*)

Operative steps:

In simple procedures,

1. Freshening edges or cutting away fibrous scar tissue, if new tissue is to receive blood vessel connection therewith;
2. Obtaining flaps, if necessary;
3. Arresting bleeding;

4. Adjusting parts in proper relation, without tension with sutures or tacks;
5. Closing gaps left by cutting out flaps;
6. Dressing wounds aseptically, and keeping them aseptic;
7. Prevention of motion and of undue handling of tissues reconstructed.

In complicated procedures,

May need a series of operations extending over months;
Each operation forms a basis for the succeeding one;
Do not attempt too much at once;
Allow time for healing and contraction.

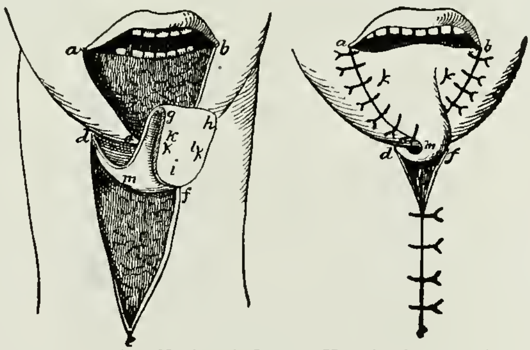


FIG. 116.—Twisted flap. (*Keen's Surgery.*)

Incisions:

In furrows, in shadows;
Oblique to make perfect apposition;
Scalpel for raising flap; midpoint scalpel or bistoury for incisions;
Broad surfaces of contact when edges are to be united, as in harelip and cleft palate.

Suturing:

Wire, worm gut, thread, horsehair for apposition of edges and surfaces.
Interrupted, intracutaneous, mattress, tongue-and-groove.
Oblique to cause pouting or dimpling.
Buried catgut or wire.
Sustaining sutures, with or without plates or pads.
Rubber shotted sutures.

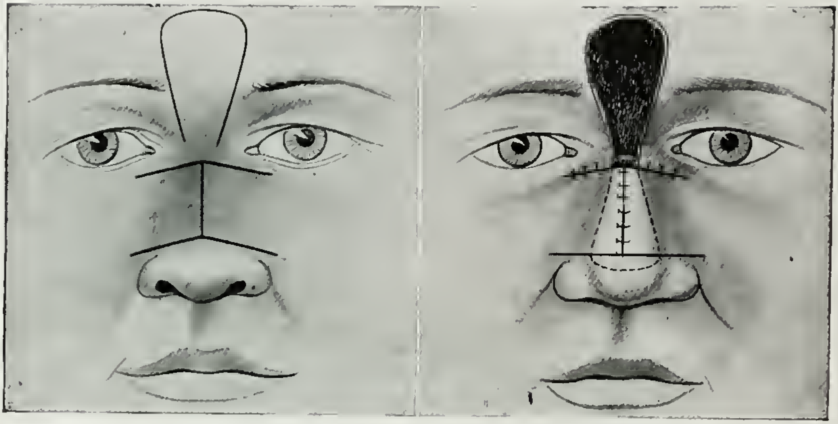


FIG. 117.— Superimposed flaps. (*Keen's Surgery.*)

FIG. 118.— A rotated flap.

Dressings:

Mild antiseptic solution be painted along wound if pediculated flaps used.

No antiseptic may be used with transplants (grafts).

Dry gauze dressing, aseptic of course.

Perhaps warmth by dry heat outside dressing, when blood supply is doubted.

Keep wound quiet and do not disturb dressings early or often.

FIG. 119.— Rotated flap from cheek to repair ala of nose. *(Keen's Surgery.)*

Face wounds will do very well without any gauze dressing. I usually prefer none, or but a *single* layer of dry gauze.

Do not uncover wound earlier than fourth or sixth day, if free from contamination with saliva, or mucus from nose or eye.

METHODS OF PLASTIC SURGERY.

A. Displacement:

I. Simple approximation after freshening edges; harelip, vesico-vaginal fistule.

II. Sliding into position after transferring tension to adjoining localities; ectropion, contractions after burns

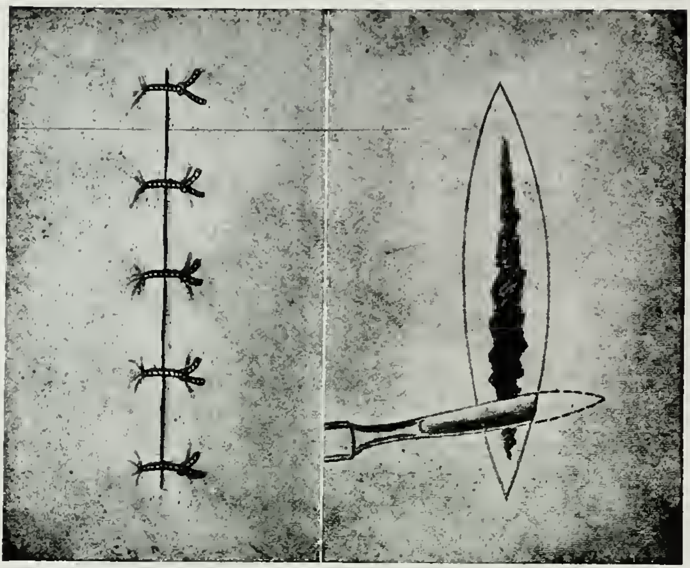


FIG. 120.— Undercutting edges of ulcer or scar to lift up and slide borders over a depressed area. (*From Roberts's Modern Surgery.*)

B. Interpolation:

Borrowing material from near regions; from a limb, another person or animal:

I. Transferring flap with pedicle:

(a) Putting in place at once:

1. Rotating flap in same plane on a pedicle.
2. Twisting flap on pedicle, as in making lower lip from upper.
3. Everting flap.
4. Super-imposing one flap on another, as in exstrophy of bladder.
5. Jumping or carrying flaps across a bridge of skin and suturing only the end.
6. Slipping flap through a button hole.
7. Folding flap upon itself.

(b) Putting in place by successive migrations.

FIG. 121.— Meloplasty by cervical flap and buttonhole.
(*Roberts's Deformities of Face.*)

II. Transportation with pedicle:
(a) Direct — Tagliacotius method from arm.
(b) Indirect — Using hand or finger as carrying agent from abdomen or thigh.

III. Transplanting without a pedicle (grafting):
(a) Suturing, or holding, in gap tissues dissected recently from distant parts, or other animals or men.

Skin { Réverdin — particles of skin; Thiersch — shavings of skin; Wolfe or Krause — whole thickness skin.

Mucous membrane, adipose tissue, fascia, cartilage, bone, nerve.

C. Enthesis:
Paraffin, wire, rubber, glass, gold.

D. Retrenchment:

I. Cutting out ellipses — cystocele, rectocele.

II. Cutting out triangular pieces or wedges.

Emmet's perineal operation, Roberts's rectal prolapse operation.

Reducing gigantic noses or ears.

Is valuable because reduces proportion.

E. Substitutive, using one organ for another, as caecum for bladder, appendix for urethra, intestine for vagina.

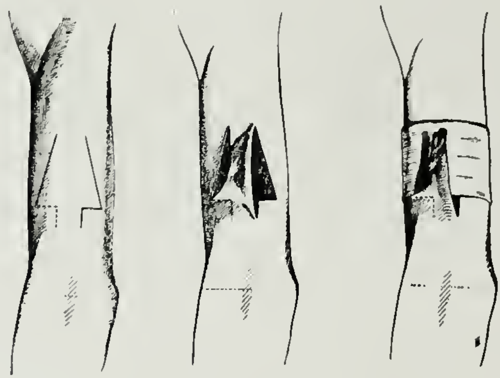


Fig. 122.—Dieffenbach's method of modeling brachital flap before attaching it to nasal region in rhinoplasty.

F. Strategic:

Temporary displacement, as dividing mandible to reach throat and palate, cutting zygoma to get at base of skull;

As displacing upper jaw or nose to gain access to naso-pharyngeal tumors.

1. Manner of making cutaneous flaps with pedicles:

Make them large, thick, with good vascular supply through wide pedicle.

Artery and vein may be in flap or partly denuded of skin.

Subcutaneous fascia must be included.

Because skin is elastic, make flap 30 to 40 per cent. larger than opening to be covered.

FIG. 123.—Tunnel flap for subcutaneous transfer of tissue of thigh to repair thumb. (*Keen's Surgery, after Haubold.*)

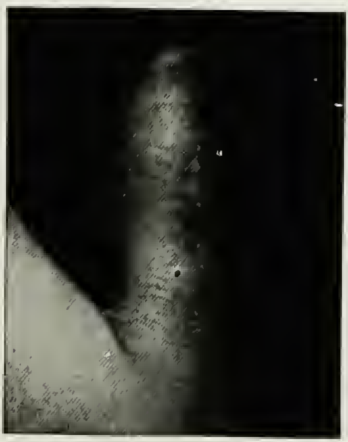


FIG. 124.—Lacerated thumb after subcutaneous transfer of integument Ultimate result about five months after original operation.
(*Keen's Surgery, after Haubold.*)

Freshen edges of gap to be covered by cutting away fibrous cicatrix before making flap.

Base of flap towards cardiac end of artery running into base.

Long axis of flap corresponding with direction of arterial supply.

May neglect this rule, if anastomosis free.

May be well sometimes to cut flap and wait a few days before stitching it in place.

Do not twist pedicle so as to close artery.

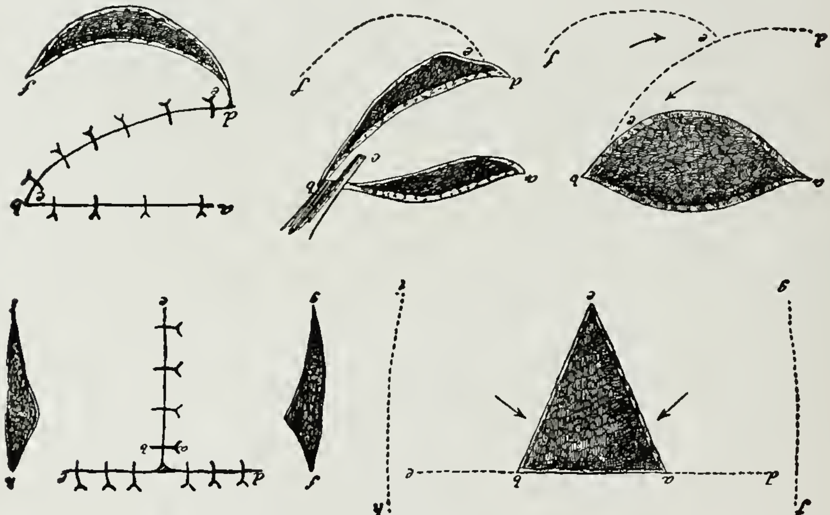


FIG. 1[illegible].— Methods of relaxing tension with curved and angular margins.

Do not impede arterial or venous supply or discharge by tension.

If either event is evident on second day, take out stitches to restore arterial current, or puncture flap to lessen venous engorgement.

Injurious tension may be relieved by making pedicle with curved or angular borders.

Stop hemorrhage before applying pediculated flaps and lay in place loosely, not in a stretched condition.

2. Manner of making transplants.
   - Tissues must be aseptic, not antiseptic.
   - Grafts must be aseptic and not injured by mechanical or chemical irritants.
   - Sterilize surfaces to be grafted and surfaces from which grafts are to be obtained, if not already sterile.
   - If antiseptics have been used, bathe surfaces with sterile normal salt solution.
   - Keep grafts wrapped in dry gauze at operation.
   - Carrel uses grafts kept in cold storage for long period.

FIG. 126.— Plastic transportation of cellulocutaneous flap from thigh or abdomen to face in plastic repair of nose, lips or chin. Hand showing skin surface of flap taken from thigh and satisfactorily used in rhinoplasty for syphilitic deformity of nose. (Polyclinic patient.) Note suture scars where flap has grown fast to ulnar side of hand. Opposite edge of flap shows thick pad of adipose tissue under skin. This border was sewed against raw surface of face, and the band cut loose from other border of flap two weeks later.

   - Pieces of skin, nerve, fascia, adipose tissue, tendon, cartilage, bone, may be used as grafts.
   - Skin grafts of whole thickness should have adipose tissue clipped off.
   - Place graft in contact with like tissue where gap exists.
   - Hold graft in place by pressure or sutures.
   - In skin grafting press out air under graft.

3. Results:
   - Pedunculated flaps or grafts that remain healthy for three or four days are not apt to slough.

If within this period flap or graft becomes grayish, pulpy and shows loosened cuticle, venous gangrene is probable.

If, however, it becomes whitish, then dark and withered, arterial gangrene is probable.

If gangrene seems imminent, it is possible that only an upper layer or the edges will die.

Hence do not cut away slough too hastily.

In arterial gangrene, take out sutures that seem to cause tension even if one separates the whole flap except pedicle.

In venous sloughing scarify the surface of flap or make deep punctures to let out blood, as well as relieve tension of pedicle by cutting a few sutures or untwisting pedicle.

FIG. 127.—Bone grafting of fibula. Condition of bones fourteen months after operation. *(Janeway, from Keen's Surgery.)*

CHAPTER XVII.

PLASTIC SURGERY OF FACE IN GENERAL.

Operative repair by plastic procedures is very essential in wounds of the hard and soft tissues of the face received in war. The problems presented to the surgeon are more difficult than those usually seen in civil practice. The civil surgeon, however, gains considerable experience in such reparative treatment in the congenital deformities. Military surgeons have learned that the final plastic reconstruction is much simplified, if the treatment employed immediately after the traumatism has tended towards restoration of original contours. Thus are greatly lessened displacements by muscular action upon broken bones and grave displacements from contraction of fibrous tissue in scars.

The general principles of plastic surgery obtain in this form of reconstruction. It must be admitted that great improvement has been made by the skillful construction and adaptation of prosthetic appliances and temporary expedients for holding tissues in proper position by military dental surgeons. They are particularly facile in the use of artificial expedients for filling out gaps left by avulsion of tissue, and in applying the mechanical principles of dentistry to recent wounds. Large masses of muscle, fascia and skin may be held in place by trusses constructed on the principle of the hernia truss. Springs and bars attached to vulcanite plates, fitting the contour of forehead and cheeks, may be used to give attachment to pads for utilizing pressure or traction. Bars and levers taking their support from the teeth may be used to constantly exert traction at points and in places where sutures would soon be rendered useless by infection. Civil surgeons have not used devices of this sort with sufficient skill or accuracy to appreciate their full value in replacing displaced tissues.

Truss-like supports, made in the manner suggested with a bearing on the head or chin, can be so arranged as to exert pressure like that of the surgeon's fingers upon the surface of the face at the necessary point.

It is possible to get rid of the cutting action of sutures, in wide wounds requiring tension for closure, by sewing a series of hooks

on pieces of canvas or adhesive plaster and so placing these along the sides of the wound as to permit lacing similar to that which is used in closing shoes over the foot. This resembles somewhat the scheme of supporting abdominal incisions by strips of adhesive plaster with tapes at their ends to tie over the gauze dressing at the wound. Collodion may be used to fasten the device for lacing, if adhesive plaster is thought inadvisable.

Plastic repair, when complicated by fracture of the underlying skeleton, should be preceded by fixation of the bony fragments. In war surgery this reduction with fixation should be made as early as possible. In many cases it is practicable at the original dressing. Sometimes it may even be a first-aid dressing; in any event, it should, if possible, be not delayed more than a few days after the receipt of injury.

The most important fractures are those involving the maxilla and mandible. The deformity may be very great and much loss of substance of one or other jawbone is frequent. The teeth furnish, if present, a useful guide to the proper position of the fragments of the mandible. The occlusion of upper and lower arches should be secured without reference to the amount of lost tissue between the ends of the injured bone. If much substance is lost an inexperienced hand must not insist upon bringing the fragments in contact in order to close soft tissues over the coapted ends.

It should be practically an invariable rule to secure the mandible in a satisfactory occlusion with the teeth and arch of the upper jaw. As has been mentioned previously, a temporary block of modelling compound may readily be fitted between the ends of the bone to occupy the gap produced by the projectile. After a few weeks, muscular displacement will be less likely to occur, even when the artificial substitute is taken away. Early, as seems wise from the condition of patient and wound, it is desirable to make a permanent prosthetic appliance, or endeavor to close the gap by osseous or cartilaginous grafts.

The exact method of fixation will be determined by the number and position of the teeth present in upper and lower jaw, the character and line of the fracture, the comminution of fragments, the amount of lost bone and the particular muscles causing the displacements.

After operations involving removal of the floor of the mouth, the base of the tongue, to which the genial muscles were attached, may be stitched to the soft parts near the hyoid bone to prevent falling backward upon the epiglottis, causing dyspnoea. During convalescence the sutures may be removed and a little operation similar to that done in children with tongue-tie be performed.

X-ray examination by fluoroscope or plates is often essential in establishing a diagnosis and in proving the efficiency of the fixation apparatus. By it the line of fracture, the presence of foreign bodies shot into the tissues, the displacement of small pieces of bone, and other important facts, are readily determined. Anesthesia may be required for carrying out in an efficient manner the examination, sterilization and temporary treatment of these gunshot wounds. Except when these procedures are performed by lamp light or near a fire, inhalation of ether will be very satisfactory in a large number of cases. The anaesthetic sometimes may be administered with more convenience with tubes pushed through the nostrils into the nasopharynx, by intratracheal anaesthesia, or by means of a rubber bulb and container blowing the vapor through a tube introduced at the corner of the mouth. Local anaesthesia by nerve blocking or infiltration of sterile novocain solution or other anaesthetic agent, with a powerful hypodermic syringe, may be used. This method is probably not employed as much as it should be.

The permanent fixation of fractures may at times require something more substantial than the temporary dressings already described. Casts of the mouth and preliminary impressions of the teeth and alveolus should usually be made by the expert dental surgeon. To such an expert also should be confided the more complicated forms of splint and apparatus utilized for permanent treatment.

Secondary hemorrhage in septic wounds may occur from the facial, temporal, internal and maxillary arteries at about ten days after the injury. The caretakers of the patient should be on the watch for this dangerous complication due to sloughing of the arterial coats. The same complication may arise when the wounds involve the cervical or submental region. The external carotid artery or the common carotid itself may at times be the

proper vessel to subject to ligation in continuity. The surgeon should not delay long the operation for securing the proper vessel at a distance from the wound, if he finds that packing of, and ligation in, the wound are inefficient remedies for the secondary bleeding. The anastomosing circulation is so readily established in the neck and face that it is wise, as a rule, to ligate the vessel, which is to be tied in continuity, in two places about half or three-quarters of an inch apart. The vessel should then be cut between the ligatures. This prevents recurrent bleeding from the distal end.

Temporary occlusion of the facial artery as it passes over the lower border of the mandible on one or both sides may be easily accomplished, before extensive operative work upon the face, by an acupressure pin or ligature being passed under the vessel subcutaneously. When the incisions at the distal side have been completed, the occluding pressure may be released. The carotid current can be temporarily controlled in a similar manner by a band or flat ligature applied through an incision exposing the vessel. In cases of major importance this expedient is valuable and should be adopted.

Among the complications of bad injuries of the face are septic pneumonia, inspiration pneumonia from inhalation of particles of septic material while under anaesthesia, and the hypostatic congestion of lungs due to prolonged recumbency with enfeebled general circulation.

The advent of septic inflammation of the lungs is best prevented by thorough drainage and frequent sterilization of infected peripheral wounds. Careful administration of anaesthetics, the adoption when convenient of local anaesthesia, and care not to make anaesthesia so deep as to blunt laryngeal reflex sensibility by too deep narcosis will lessen the probability of inspiration pneumonitis. The sitting posture or a change from one lateral to the other lateral recumbency will have a beneficial effect in averting hypostatic congestion and inflammation of the pulmonary structures. Protection with warm undershirt from chilling and exclusion of cold draughts from a seriously ill patient after anaesthesia will be recognized as of value by careful surgeons.

One must not forget the possible complication of meningeal

and cerebral septic inflammation, when fractures about the upper portion of the face make fissured fractures of the base of the cranial cavity. The orbital and temporal regions are especially liable to such contingency. It also must be recollected that venous thrombosis of septic origin may travel rapidly from wounds of the facial tissues through the veins, which in this region are much less well provided with valves than in other quarters. Intracranial involvement from any of these causes demands the specific medication recognized as indicated. Hexamethylenamin given internally is by many thought to be a valuable antiseptic remedy.

The cutaneous covering of the face is thin, elastic and very vascular. It does not slide very freely over the deeper tissues, because the many muscles of the face are inserted into its lower surface for the purpose of causing wrinkles and giving expression to emotions. Its vascularity and elasticity render it particularly suitable for plastic procedures. If loosened from its deep attachments with the knife, it can be stretched into new positions, without much probability of sloughing occurring from limitation of blood supply. The tissues of the face are so mobile and susceptible of stretching that a distinguish English surgeon has said that he could construct a mouth out of either the upper or lower lip alone.

It is important to make incisions, when operating on the face, in such manner as will result in inconspicuous scarring. This is to be done by following the curved furrows in the skin produced by the action of the muscles and by placing the scar in the places usually obscured by shadows or hair. When this cannot be done the cut should be made parallel to the facial lines of the region rather than across them. A slightly curved line makes a less conspicuous scar than a straight or abruptly curved one. Under the eyebrow, beneath the lower edge of the jaw, behind the ear, and around the wing of the nose are regions usually in shadow. The crow's-feet at the external angles of the eye, the curved wrinkles in the forehead, and the naso-labial furrows, are indications to the thoughtful operator of the situation and direction most appropriate for operative wounds. Incisions made in these furrows or parallel to them leave little noticeable scarring.

Sometimes the incision may be made through the hair of the scalp or the beard, and the skin may then be drawn aside, so as to expose the deep structures at a considerable distance from the cut.

Accurate apposition of the edges of a wound is best obtained in incisions dividing the skin somewhat obliquely to the plane of its surface. The bevelled edges of skin thus made fit accurately

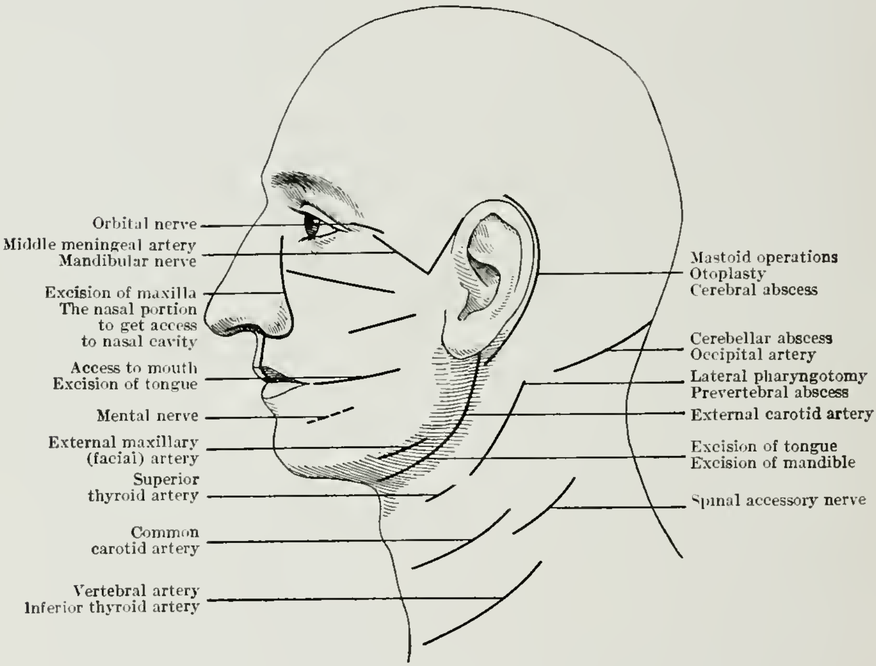


FIG. 128.—Diagram to show where incisions cause least disfiguring scars—Kocher's "normal" incisions in direction of "cleavage" lines of the skin. (*Modified, from Kocher.*)

together and cause very little scarring. Scars received in childhood increase proportionately with the growth of the patient. This circumstance may cause cicatrices which seem insignificant in childhood to become marked defects in adult life, though the original induration and discoloration about the scar have long disappeared.

Bleeding is free in operations upon the face, but soon ceases if pressure is made with hemostatic forceps or sponges. Operating with the patient semi-erect lessens the bleeding. Torsion or ligation with cat-gut may be occasionally required. Acupressure or tempory subcutaneous ligation of the facial arteries, where they cross the lower jawbone, will diminish the blood supply

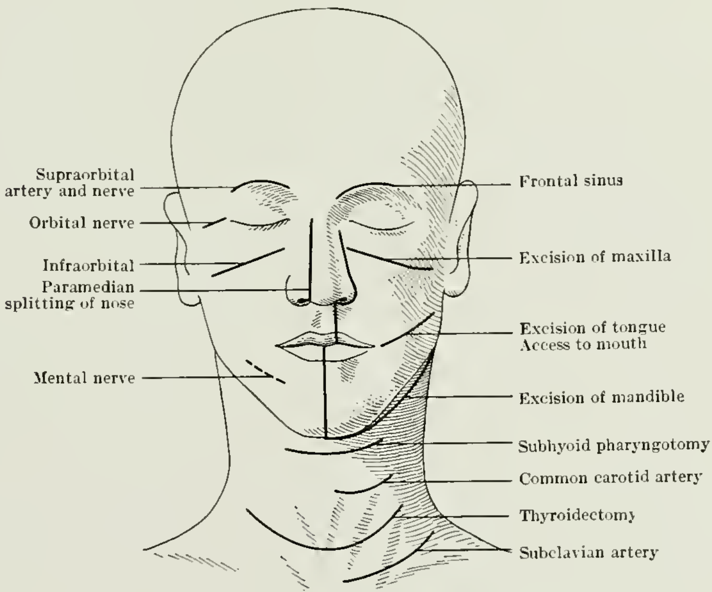


FIG. 129.— Kocher's normal incisions in direction of cleavage of skin leave slightly disfiguring scars. (*Modified, from Kocher.*)

during the time of operation. Digital compression may be used on the external carotid arteries just below the ear to make the temporary anemia more complete. To be of service the arteries of both sides of the face should be controlled. In very serious operations upon the face both common carotids may be temporarily clamped.

Septic inflammations after operations upon the face may usually be avoided by thoroughly sterilizing the parts prior to operation and before applying the sutures, and subsequently keeping the wound perfectly dry or removing all secretion by

frequent antiseptic mopping. The instruments, hands and articles used at the operating table must be carefully made, and kept aseptic as in other surgical procedure.

Valves are not common in the veins of the face. This circumstance and the free communication of the facial veins with the internal jugular veins and cavernous sinuses are given as reasons for the rapid spread of septic inflammations which may occur in the tissues of the face.

The bony framework of the face has a good blood supply and is not likely to become necrotic unless septic inflammation of a high grade is present. The bones are comparatively soft and do not split easily when broken. Union after fracture or incision occurs with rapidity. There seems to be a certain amount of elasticity in the bones of the face which enables them to regain the normal contour, if the displacing pressure has not been great.

The soft tissues are similarly well supplied with blood and will often recover from severe injury which in other parts of the body would lead to local gangrene. The maintenance of an aseptic condition and the application of heat to the damaged structures will often result in saving tissue apparently devitalized. Frequent irrigation, with sterile normal salt solution or weak antiseptic solutions, of the temperature of 105° F., is a serviceable means of obtaining the conditions mentioned if suppuration has occurred after operation or injury. Dryness of the surface after the sutures have been applied is very valuable. I frequently interdict washing the face after rhinoplasty, and other operations, allowing the patient to sponge merely the skin at a distance from the wounds, for the morning toilette. Dry heat is better than moist heat if the wound is aseptic and gangrene is feared from anemia alone. Portions of the nose, ear, or lip, which have been torn or cut off, may be readjusted and sutured in their normal position with a fair prospect of union taking place.

Plastic procedures upon the face may involve extensive areas without grave danger of the result being interfered with by gangrene of the flaps. Accidental injuries should be treated on this basis and no sacrifice of doubtful tissue should be made until the impossibility of its preservation has been established by the actual occurrence of sloughing. The most perfect approximation of the edges of cutaneous incisions is obtained when the

incision has been made obliquely to the plane of the surface. Such bevelled edges are brought together with great accuracy if fine needles and sutures are employed. Accidental wounds will at times cause less scar if the edges are trimmed obliquely in opposite directions before sutures are inserted. The intracutaneous or subcuticular suture is not necessary, but may be used if it is readily applied in the region operated upon. I use interrupted sutures. Horsehair is not strong enough if there is tension on the suture.

Fine silk, silkworm gut, or Pagenstecher linen thread is good suturing material for wounds of the face, as ordinary catgut may be absorbed at a too early period and allow separation of a portion of the wound. In applying the sutures a line for the scar should be chosen which will displace by contraction the eyelids, alæ of nose, or mouth, as little as possible. It should be at a right angle to the line of the tissue which the surgeon fears may be displaced. The twisted or pin suture is always undesirable in the lips or face. It is not needed even in harelip operations. A little piece of sterile gauze laid over the wound is a very nice dressing. I usually apply no dressing after operations upon the soft parts of the face, allowing the bloody serum and lymph oozing between the sutures from the edges of the aseptic wound to dry. If it is deemed desirable, a little boric acid or acetanilid may be dusted along the edge to encourage the formation of this aseptic scab. These methods of dressing are less cumbersome and therefore more agreeable to the patient than great bundles of gauze held upon the face by means of bandages. The least evidence of suppuration under the scab must be an indication to soak the crust with an antiseptic lotion and remove it. If this is not done promptly pus will burrow and render rapid union impossible and scarring likely. Then frequent cleansing with an antiseptic solution, such as di-chloramine T or mercuraphen, is important.

Drainage is seldom needed in wounds of the face and should be avoided whenever possible, as it tends to increase the disfigurement from scarring. The sutures in aseptic small wounds should usually not be allowed to remain more than five days. In large wounds, ten days is not too long.

In external wounds involving the cavity of the mouth a series of sutures introduced from within the mouth to hold the edges of the mucous membrane together will be advantageous. The germs contained in the mouth are then less likely to gain access to the surfaces of the wound and the cutaneous portion is more likely to unite by first intention. Sometimes it is wiser to leave the mucosa unsutured so that drainage may occur into mouth to save escape of pus by skin surface.

When operating upon the exterior of the cheek, the surgeon should avoid incising the mucous membrane whenever possible. Contamination from bacteria within the mouth is thus avoided. Drainage when necessary should be connected with the mouth, thus avoiding the scarring of the external surface by drainage or tubes.

A neat method of approximation which causes only one or two needle punctures on the external surface is by a subcuticular or intracutaneous continuous suture. Fine linen or silkworm gut and a small straight or semi-circular needle are employed. The needle is thrust through the skin near one end of the wound and its point made to emerge within the wound close to the extremity. By this maneuver the thread has its end anchored in the tissues. The needle is then used to draw the raw surfaces of the skin together, by puncturing the faces of the two walls of the wound successively, but never thrusting the needle through the external surface of the integument. When the wound has been thus closed along its entire extent the thread is cut off short and allowed to retract within the tissues, or the needle is thrust through the skin and brought out upon the surface at a little distance from the extremity of the wound. The thread in the latter case is cut off so as to leave an inch or so protruding. When the wound has healed, traction on either end of the suture will pull the entire thread from its position within the layers of the skin. Catgut, if used, will be absorbed and is not withdrawn. If there is much tension to be overcome by the suture it may be necessary to make a knot on the thread projecting at the first puncture, and to anchor the other end of the thread as in the ordinary continued suture. This manner of burying the sutures is unnecessary if oblique incisions and small needles are used in

the ordinary way with the maintenance of a perfectly aseptic wound.

Incisions in the middle of the cheek should be made so as to avoid wounding the duct of the parotid gland. This duct is beneath the deep fascia and runs in a line drawn from about the middle of the lobe of the ear to a point midway between the wing of the nose and the angle of the mouth. When the duct reaches the anterior edge of the masseter muscle, in its course forward from the parotid gland, it dips inward toward the mouth, perforating the buccinator muscle and the mucous membrane in an oblique direction. It enters the mouth opposite the second molar tooth of the upper jaw.

When it is impossible to avoid cutting this duct, the portion between the incision and the parotid gland should be separated from the surrounding tissues for a short distance and carried into the mouth through a new opening in the mucous membrane and other tissues of the cheek. The device, if successfully accomplished, carries the saliva into the mouth and prevents the formation of a salivary fistule on the outside of the cheek. Incisions under the outer angle of the supraorbital arch may, if very deep, injure the lachrymal gland and lead to lachrymal fistule.

The branches of the seventh nerve radiate from a point a little below the external ear. The muscles of expression in the face will be paralyzed if these nerve branches are cut. The motor paralysis, due to injury of the branches of the seventh nerve, renders the patient unable to close his eye, permits the mouth to droop on the injured side, and renders the face on that side expressionless. Injuries to these nerves are therefore very unfortunate occurrences. Vertical incisions in front of the ear are therefore to be avoided. The branches of the fifth cranial nerve, which give sensation to the face, make their exit from the supraorbital, infraorbital, and mental foramina. Injury to these sensory branches is not a matter of much consequence, as loss of sensation so produced makes no difference in the appearance of the face, and is usually slowly recovered by neural regeneration.

Plastic surgery is often called into requisition to repair deformities of the face, the result of injury or disease, or congenital malformation. Industrial accidents and warfare are productive

of frightful facial wounds. These need immediate reconstructive surgery and at a later period cosmetic improvement by surgical operation or prosthetic appliances. Displacement of tissue by stretching or sliding, transferring a flap with a pedicle, and transplanting shavings or grafts of skin or other tissue, are often useful in correcting such disfigurements.

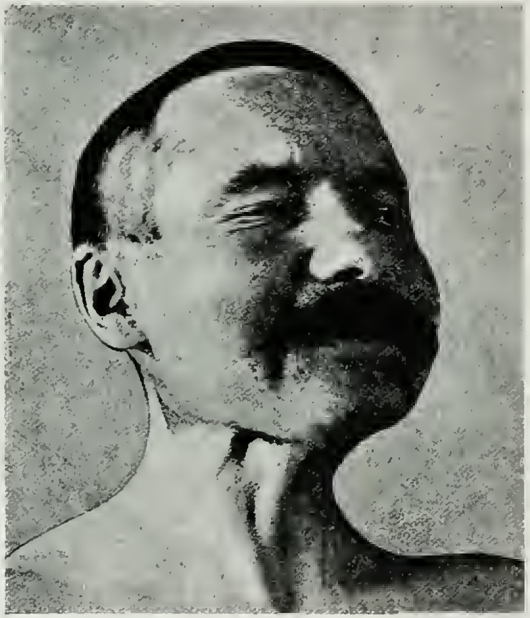


Fig. 130.— Facial nerve branches may be preserved by transverse incision from corner of mouth. Patient showing full action of the muscles of the right side of face after excision of tongue through a transverse incision from angle of mouth. (*From Kocher.*)

Sometimes the pediculated flap cut for repairing a gap is not sutured into the place intended until inflammatory changes have increased its vascularity and thickness. It is less liable to slough under these circumstances than when subjected to the stretching necessary to put it in proper position just after it has been cut and while it is somewhat lowered in vitality. It may be allowed to lie loosely upon a piece of rubber tissue or oil silk inserted between its lower surface and the tissues beneath. It will thus

be prevented from becoming adherent to the subjacent structures. In three or four days it will have an unusual blood supply coming to it through its pedicle as the result of the inflammatory irritation produced by the injury sustained when it was cut.

Plastic surgery may have for its object the curtailing of abnormally large organs as well as the repair of destroyed or deformed ones. Thus the reduction of a large nose, lip, or ear is properly a procedure in plastic surgery. Constructive operations usually make use of the skin and subcutaneous cellular tissue, or the mucous membrane. The former, when turned into a cavity such as nose or mouth, becomes a pseudo-mucous membrane. The latter assumes a character somewhat like that of the skin when placed upon the external surface. Muscle, tendon, nerve, periosteum and bone are employed in some reparative operations.

Plastic operations should not be done while the pateint is in poor health, nor when septic contamination of the wound is particularly likely to occur. Asepsis of wounds is of primary importance. Deformities due to syphilis should not be corrected by operation until the syphilitic process has been stayed by active specific treatment.

It often requires a series of operations to obtain the best cosmetic result. The major portion of the operation may frequently be done at first, and great improvement obtained later, because the new tissue may then be shaped with more accuracy. Time should be given, between two such operations, to permit the shrinking which occurs when the inflammatory exudate is absorbed. It is much better to have too much tissue than too little, in the first stage of the operation, if the plastic procedure is undertaken to restore a lost part.

Care in introducing sutures will permit the surgeon to cause apposed edges to protrude a little or to be depressed. The obliquity with which the suture needle is carried through the skin determines which of these conditions is obtained. The selection of points for putting in sutures also determines where the tension will come. Sutures crossing the wound obliquely enable the surgeon to distribute tension in various areas.

Three general methods of operating include most, if not all, plastic operations. The first is by stretching or sliding tissue and may be called the method by displacement. One of the

forms of displacement is simple approximation after freshening the edges, as in harelip operations and in remedying the ugly notches found in the lobe of the ear after an earring has been torn from that organ.

A second form of displacement is sliding the skin into position after transferring the tension to an adjoining locality. This means is employed in lifting up the lower eyelid by a "V"-shape incision in cases of ectropion. The linear incision sometimes made to permit the skin to be pulled laterally over wounds is another illustration of this second form of displacement.

In the method which may be called interpolation, the tissue to be used is taken from an adjacent region, from a limb or even from another person or animal. Under this treatment are included transferring a flap with a pedicle, transplanting tissue without a pedicle, and grafting a piece of tissue from the thigh or abdomen into the hand and subsequently inserting it into the face or elsewhere, by using the arm and hand as a means of transportation. The flap with a pedicle, by which it receives its blood supply, may be rotated in its own plane through a quarter or half circle, as in making an eyelid from the forehead. It may be twisted on its side, as in forming the wing or lateral portion of the nose from the upper lip or forehead. Sometimes the flap is turned entirely over so that the raw surface is uppermost.

One flap may be superimposed upon another, as in one of the operations for forming a nasal bridge, where the forehead flap is turned downward and a flap from the cheek on each side of the nose drawn over it and sutured in the middle line. A flap may be jumped across a bridge of skin, its end being used to fill a space on the far side of the bridge of healthy skin. The pedicle is usually divided in such cases when the flap has become attached in its new position.

Transplantation without a pedicle was seldom serviceable, except in skin grafting, until surgeons obtained a knowledge of the means of preventing suppuration in wounds. It was used with considerable success, however, in the transplantation of minute pieces of skin. Now, however, large shavings of skin are constantly and successfully employed to cover recent wounds and granulating surfaces. Quite large portions of the entire skin may be successfully transplanted if the operation is done asepti-

cally and the wound kept free from antiseptic or other irritants. It is best to have the tissues absolutely dry. Wolfe and Krause have advocated this method. Portions of bone and nerve as well as skin are also quite frequently transplanted. Tissues taken from the lower animals or recently amputated limbs are sometimes used, though the patient's own tissues are more frequently utilized. Mucous membrane and adipose tissue are used as grafts with success.

Portions of ear and nose which have been cut off by accident may be sutured in place with a reasonable hope of union occurring. To accomplish this the parts must be aseptic when applied, and must be kept so for a number of days until union is established. The maintenance of heat in the severed part is important. Hot normal salt solution and solutions of boric acid and other mild non-irritating antiseptics are often used for this purpose. There is no reason why a nose or ear may not be reconstructed, with almost certain success, from portions of these organs deliberately cut from other persons, if the latter are willing to undergo the mutilation. Dry sterile gauze is usually better than wet dressings in plastic operations on the face. It may be kept dry and warm by placing a bag of sand or hot water near the part. Many face wounds do well without any dressings if the operative incisions have been free from micro-organisms. The dried blood uniting the lips of the wound is all sufficient. The patient should not wet wound when washing the rest of the face. Plastic operation wounds should not be redressed too soon. Removing dressings disturb the healing process by displacing edges, causing slight bleeding and possible contamination, and by permitting the surface to become moistened. A week is time enough to look at the wound provided pain or general disturbance does not occur.

Retrenchment removes unnecessary tissue and improves the appearance of the part by cicatricial contraction. Examples of this method in plastic surgery are the removal of elliptical or semi-elliptical portions of tissue in drooping of the upper eyelid, the cutting away of triangular or wedge-shaped pieces of skin or muscle in lessening the bulk of the lower lip or tip of the nose, and excision of angiomatous tissue from under the skin of the cheeks.

Retrenchment is also of service in the cosmetic surgery of the face by altering the comparative size of features. A flat and tense lip after a harelip operation is made to look more comely by cutting a wedge-shape piece out of the center of the lower lip. This retrenchment of the normal lower lip makes the tight upper lip much less noticeable. In the same way, removal of a portion of the upper lip will make a small nose seem more prominent.

Successful plastic surgery is more apt to be obtained when the patient is in good general health, and when the seat of operation is free from septic inflammation. Healthy integument should always be used for the formation of flaps, if it is possible to obtain it. Cicatricial tissue has less blood supply and consequently diminished vitality; it is apt to undergo anemic gangrene when dissected from the neighboring tissues, even if the pedicle is a broad one. Plastic operations by the methods of approximation and sliding interfere less with the vascular supply than do transferring or transplanting flaps. Therefore, cicatricial tissue may be employed more freely in the former than in the latter methods. The fibrous tissue in and at the edges of old wounds must be freely cut away when grafts or flaps are to be applied to close gaps or alter contours.

Pedunculated flaps should contain a good deal of subcutaneous tissue in addition to skin; such flaps contract less and are more vascular. They should have a wide pedicle and should be about one-third larger in area than the space to be covered. Free flaps, or grafts, should have the subcutaneous fascia all removed. They should be perhaps a little larger than pedunculated flaps. The parts to be repaired should be freshened before the flap is cut, because the tissue that is to be transferred or transplanted may then be promptly put into its new position before it loses its normal heat. Some surgeons make a diagram of paper before beginning a plastic operation, and then mark a similar outline with ink upon the skin. This is as a rule unnecessary.

The long axis of a pedicle should, if possible, correspond with the direction of the arterial supply. This is less necessary in operations upon the face than elsewhere because its blood supply is very abundant and anastomosis free. The calibre of the vessels in the pedicle should not be diminished by too great tension or twisting. It is often well to make a pedicle with curved

margins, which will sustain a certain amount of additional stretching without injurious pressure upon the vessel walls. Provision for venous return through the pedicle is important, lest venous engorgement encourage bacterial contamination and obstruct arterial entrance. Moist gangrene then occurs. In transplanting large masses of tissue the main arteries and veins of the graft may be united with corresponding vessels of the part under reconstruction by angiorrhaphy or phleborrhaphy. The work of Carrel has shown the value of this procedure. Obstructed arterial circulation leads to dry gangrene. A flap showing venous engorgement may sometimes be preserved from sloughing by making multiple incisions or scarifications on its surface.

A flap which is too large can easily be retrenched at the time it is put into its new position, but a small flap will never bear much stretching, to increase its size, without danger of interfering with its nutrition. The gap which is to be filled looks larger than it really is, because of retraction of its edges. When these edges are brought into contact with the margins of the flap by sutures, the area to be covered by the flap is considerably lessened. Skin as free as possible from hair should be chosen for plastic procedures unless it is desired to replace an eyebrow, or repair a part of the face ordinarily covered by the beard.

When a gap is to be closed by interpolation or parts united by approximation, the surfaces should be freshened by such free incisions as will give a broad surface of contact. A thin raw edge gives little opportunity for firm union. After the hemorrhage has been controlled, approximation should be made by sutures which will hold the parts together without tension.

In the formation of noses and ears, the surgeon should at first be satisfied with obtaining a bulky semblance of the organ. A more accurate configuration can be obtained after cicatricial contraction has taken place. It is unwise at the first operation to endeavor to obtain a perfect result and thereby probably use too little tissue. In extensive operations a too zealous desire for immediate correction of deformity may cause death from shock or bleeding.

The least degree of scarring will be obtained after healing by first intention; hence the demand for perfect asepsis. It is diffi-

cult to keep parts free from germs if near the nose, eyes or mouth, since contamination occurs from the fluids escaping from these organs. Therefore, washing the parts with sterile normal saline solution or a mild antiseptic solution just before inserting the sutures, and again before applying the dressings, will be found very serviceable in the prevention of sepsis.

When transplantation without a pedicle is undertaken, the tissues which are to be employed must be kept aseptic during the interval between their excision from the normal position and their insertion into the new locality. Pieces of bone, nerve and skin thus employed should be wrapped in aseptic towels. Carrel has kept tissues for grafts in cold storage for months and uses them with excellent results. He has also proved that tissues will grow in test tubes if kept in proper fluids and at a proper temperature. After transplanting skin or other tissues on the surface of the body, it is well to cover the surface with a single layer of sterile gauze to lessen the risk of displacement from movements or the removal of dressings. Some operators use a large mesh netting, the fibers of which are coated with rubber or paraffin. A dry dressing is applied over this veil and only removed after the lapse of five, ten or fifteen days. The veil may be fixed in place with a little flexible collodin at the margins.

If gangrene of a flap does not occur previous to the fourth day, the integrity of the transplanted or transferred tissue is pretty well assured. A grayish and pulpy appearance of the flap with suppuration of the cuticle indicates moist gangrene. If the tissue becomes black and dry, anemic gangrene has occurred. Gangrene will to a greater or less extent interfere with the success of the plastic operation. The parts in dry gangrene should, however, be left undisturbed in the hope that the mortification will be limited. If moist gangrene occurs it is probably due to the action of pathogenic germs. Rather active irrigation with sterile salt solution or mild antiseptic lotions, and frequent change of dressings, are indicated. This is not the case in dry gangrene. The gangrenous portion should not be removed by cutting away the tissue until it is very certain where the process will stop. Quite often the death of tissues is limited to the edge or superficial layers of the flap. Some tissue in the center or on the lower surface of the transplanted or transferred flap may retain vitality

and will often render the operation more successful than would have been supposed from the appearance when gangrene began. Sometimes the flap becomes blue from venous engorgement due to the twist in the pedicle; then it will look as if gangrene was about to occur. The venous stasis may be great enough to cause gangrene. Incision of the flap in several places may drain out this blood and save the tissues from sloughing.

Esser's epidermic inlay in combination with dental modelling compound is a valuable suggestion. To avoid irregular healing of Thiersch grafts, he applies and spreads the grafts evenly and maintaining them immovable under equal pressure for several days He exposes the surfaces of the wound carefully and makes an impression of its surface in warmed dental modelling compound. On this negative he spreads the epidermic grafts with the raw surface away from the cooled and hardened composition. The plaque, with the grafts upon it, is then pressed upon the room for inserting the plaque. This method, he says, is serviceable to enlarge the conjunctival sac, to construct part of or the whole ear, to enlarge mucous membrane of mouth and the mouth cavity. It is available in defects of the hard and soft palate to cover various forms of skin flaps prior to their use in the mouth.

The plaque, with the grafts upon it, is then pressed upon the raw aseptic surface or ulcer, and the skin edges of the portion with which the grafts are in contact sutured over the plaque. He thus has Thiersch grafts accurately held for several days in close pressure contact with the raw wound. If necessary, he undercuts these edges before applying the grafts and thus obtains room for inserting the plaque.

To prevent contraction of the mouth after wounds of the cheeks and lips, Esser is accustomed to using a small adjustable shield in the mouth to prevent prolapse of the lips of wound. This maintains contour and preserves the buccal sulcus.

For repairing defects involving mucous membrane of cheek, it is wise to employ doubly epitheialized pediculated flaps from neck or scalp. Hair must be destroyed by x-rays if turned into the mouth.

CHAPTER XVIII.

GUNPOWDER TATTOOING AND LOCAL DISTORTIONS.

Small particles of earth, stone, metal and wood, as well as powder, are driven into the skin and the surfaces of lacerated soft tissues during war conflicts. These not only may carry infective organisms into the face, but may, if not removed, cause hard nodular elevations of the surface, or give rise to staining of the skin.

The unburnt powder, imbedded in the skin and subcutaneous tissue by injuries from firearms at close range, leaves permanent blue stains like the discolorations obtained in tattooing with black pigments. Coal miners and those injured by pieces of coal often present similar disfigurements. After such injuries the powder or coal dust, or other foreign particles, must be promptly and thoroughly removed from the tissues by vigorous scrubbing of the lacerated or burnt surface with soap and hot water and a brush. Local or general anaesthesia will often be necessary. Attempts to remove the dust-like particles with forceps will seldom be successful. When the skin has healed over the imbedded carbon, the discoloration can only be removed by excising the stained area or tediously removing each minute particle. A small circular punch shaped like the end of a watch key may be applied over each blue point, or croton oil may be picked into the discolored skin with a needle. In the latter case, suppuration will probably occur and cause extrusion of the carbon, or other pigment. The minute scars will be less disfiguring in a white patient than the tattoo marks. The combustive destruction of the imbedded carbon by introducing a red-hot galvano-caustic needle has been proposed for removing blue tattoo marks. Dermatologists employ chemical means to remove intentional tattooing, but the discolorations due to accidental wounds from firearms or coal mining injuries are probably too deep for the successful application of chemical solvents.

Thoroughness in removal of dirt of all kinds in war injuries has been insisted upon. The x-ray is an aid in disclosing the

presence of metal fragments. Other foreign bodies, especially when minute, require painstaking search for their discovery. The mechanical cleansing, obtained through scrubbing with a stiff brush and even trimming away tissue with a scalpel, will often be advantageous in preventing discoloration and scarring of the surface of the face. Excision of the discolored area and subsequent skin grafting may be a successful treatment when the pigment has already been encysted within the healed skin.

Scars unimportant in other regions are unsightly and to be avoided upon the face. Incisions made from the interior of the mouth will often be available in evacuating abscesses of the cheeks and lips. The surgeon may thus obviate cutaneous scarring in a certain number of abscesses of the face. The disfiguring scarring due to syphilitic ulcers and suppurating gummy tumors is preventable by early and vigorous treatment with large doses of mercury and potassium iodide. These conditions are usually tertiary manifestations. They demand immediate recognition and very active management on the part of the surgeon, because here, as in syphilis of the nervous centers, delay and inefficiency lead to irreparable damage to the tissues.

Lacerated wounds of the face, caused by shrapnel and shell, and destruction of tissue by infection and gangrene, are liable to lead to grave disfigurement. A main reason for such distortion is delay. Securing proper adjustment of the torn parts in the early hours of treatment will lessen immensely the chance of cicatricial contraction doing harm in traumatic displacement of soft structures. The quick application of aseptic surgery for a primary closing of non-infected wounds and the early resort to efficient antiseptic surgery to infected wounds, so that secondary closure may soon be permitted, will usually succeed in giving a fair degree of reconstruction to the damaged countenance of a wounded soldier. Further plastic repair may be carried out later, but early adjustment obviates much distortion from scar contraction.

When gangrene or suppuration has devitalized facial tissues, the process leaves, after separation of the slough or softening and discharge of the destroyed cells, ulcerated surfaces and cavities. These heal by granulation and slow epidermization, which are vital processes to close gaps in structures through the agency

of fibrous tissue. This means that there must be established a deep scar. Nature permits great contraction of the fibrous tissue to occur so as to lessen the size of the final scarring. As a result of contraction, the adjacent soft parts and even the bones are dragged into abnormal relations to one another.

FIG. 131.— Shell fracture of mandible and wounds of face. Illustrates deformity due to delay in plastic treatment. Loss of bone and soft tissues in region of chin and laceration of neck. No attempt made to keep fragments of bone in relatively normal relation. Allowed to heal with infection and slow cicatrization without fixation of fracture. Had been in military prison. (*From collection of Dr. Thos. G. Aller, Jr.*)

A similar activity of the fibrous tissue is evident when open wounds are not closed by surgical approximation of the borders of a recent injury. Hence, non-infected wounds should be

sutured soon, not only to keep out infection, but to forestall granulation and cicatricial contraction.

Infected wounds and secondary ulcers should be converted as quickly as possible into non-infected wounds; these should then be closed with sutures so as to give a proper adjustment of the bony contours and cutaneous surfaces. Primary adjustment is often easy.

Secondary adjustment of the structures of a wounded face is the bugbear of the military surgeon. Very many of the wounded cannot be given early reconstructive treatment. Yet many sorely need it. The wounded soldier soon has face wounds smeared with the earth upon which he falls when injured and obtains surgical aid long after contamination has been followed by infection.

Much should therefore be done in the early hours of treatment, when circumstances permit, to bring wounded surfaces into contact and to replace by reduction and fixation fractured bones. Sutures of various kinds, interrupted, mattress, tongue and groove, shotted or with plates to distribute tension, afford means of closing rents and reestablishing the features. Clips may be used. Strips of cloth to which hooks are fastened may be glued to the skin and the parts drawn together with laces. Bones may be fixed with inter-oral splints or supports, and soft tissues held against the skeletal pieces beneath with carpet tacks, small staples, or spring pads of vulcanite. Wires may bring about proper steadiness by being carried through subcutaneous routes into the mouth. There the teeth will provide a firm base for anchorage of the loop of wire.

Continuous sutures are frequently unwise. Drainage often will be needed in much of this kind of early plastic readjustment. Hence interrupted stitches are valuable and may be more readily cut or removed to give vent to infected serum, blood and pus.

Excision of bones, soft tissues, tumors, or malignant ulcers of the face should be accomplished by means of incisions so chosen that cicatricial contraction will do little harm to the facial outlines. It will often be necessary to fill the gap left by the excision by means of an immediate plastic operation on the adjacent skin. The extent of such operations will often seem to the inexperienced almost unjustified; but the final result will,

if the work is artistically done, prove the value of transferring cicatricial tension to regions where it will cause no distortion.

It is usually better to do the plastic operation at the time the excision is performed than subject the patient to a second operation after the original wound has healed. The healing can be hastened and the distortion greatly lessened, or entirely prevented, by such a primary plastic procedure. Subsequent operations may be demanded to neutralize minor disfigurements, but it is wise to obviate the greater part of the deformity at the time of the original wound or operation.

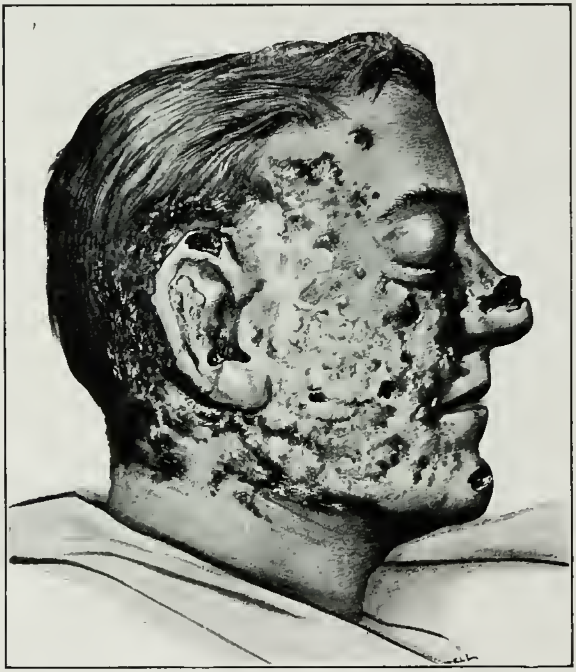


FIG. 132.—Multiple wounds of face in warfare. (*Patient in Boulogne Hospital. Anthony Bradford, British Journal of Surgery.*)

Gangrene, malignant disease, operation or injury of the cheek near the corner of the mouth frequently causes a considerable portion of the entire thickness of the wall of the oral cavity to be lost. The patient will be unable to open his mouth when heal-

ing has occurred, unless the gap in the cheek has been filled with tissue from some other locality. The cicatrix occurring even when the wound has not been sutured will irresistibly draw the jaws together, and cause a cicatricial lockjaw. This complication may be less marked when the wound has been allowed to granulate than when sutures have been used to get primary union. In the former case, however, there may be a gap left in the margin of the mouth. In either instance the disfigurement of the face will be most distressing and the function of the jaws

Fig. 133.— Cheek repaired with flap from shoulder. Pedicle was divided after flap had united wound. (*Keen's Surgery.*)

greatly impaired. Osteectomy of the lower jaw in front of the scar tissue will give mobility to the other side of the mouth, but will not alleviate the external deformity.

Plastic reconstruction of the cheek, called meloplasty, at an early moment is a proper procedure. Bardenheuer cut a flap from the forehead, turned it downward and sutured it in the gap in the cheek, with its skin surface toward the interior of the mouth. The pedicle of the flap lay alongside of the nose, and was divided after the flap became attached in its new position.

The raw external surface of the flap was covered by a flap of similar size cut from the side of the neck and rotated upward by a sliding movement. By these maneuvers the cheek was reconstructed and had a cutaneous surface on both its inner and outer aspects. The skin on the oral side of the flap becomes a pseudomucous membrane in the course of time. The gap in the forehead left by such an operation may be grafted at once with Thiersch skin shavings.

Another method of meloplasty is that in which a flap cut from the side and back of the neck is bent upward and thrust through an incision made into the mouth along the outside of the lower border of the lower jaw. It is then stitched to the edges of the gap in the cheek due to the operation or avulsion by gunshot. The skin surface of the flap is, by this maneuver, used to represent the mucous lining of the cheek. The raw outer surface is grafted with shavings of skin. The denuded area in the cervical region is grafted, allowed to granulate, or covered in by a further plastic operation. The pedicle is divided when the circulation of the flaps has been assured by communication with the vessels of the region to which it has been transferred. Sometimes the raw area in the neck may be closed with sutures, if the skin and subcutaneous fascia be undermined.

There is danger of adhesion between the inner surface of the cheek and the gums, when both have been freshened by operation or by sloughing. In such cases mucous flaps may at times be successfully dissected from the inside of the two lips in front of the affected area, displaced backward and sutured so as to prevent adhesion. There is no danger of the lips in front becoming adherent to the gums, by reason of the utilization of these flaps, because the gums opposite them have a normal mucous covering. I have satisfactorily used mucous flaps in the mouth in a similar manner when adhesion of gum and cheek from gangrene has needed operative relief.

Prosthetic appliances of celluloid, wax, metal and papier-maché have been successfully made to take the place of large portions of the face lost by injury or disease. The extent of such mutilations of military surgery in the European War has led to great advances in the manufacture of such masks and substitutes in facial disfigurements. Artificial noses, cheeks, lips, eyes and

ears may be constructed of thin metal so artistically tinted as to render the false features very presentable. The "masks" and false portions are attached to the facial foundation or stump with wax or other adhesive materials, or are given a firm hold on the head by springs, bands or spectacle frames. Artificial glass eyes are made with or without eyelids, as may be required. Artificial dentures with portions of the upper or lower jaws and well-

FIG. 134.— Disgurement of cheek and nose from war wound. Probably suited for prosthesis. (*British Journal of Surgery.*)

matched teeth are readily constructed by dental surgeons. Hollows in the surface of the face may be filled out with grafts of adipose tissue, cut from the abdominal wall, or with subcutaneous injection of melted paraffin. Artificial hair, mustache or beard may aid in hiding the deformity.

The cicatricial contraction occurring after the sloughing of deep burns produces horrible disfigurements. These rival the distortions due to gunshot injuries seen in military practice. Ectropion of eyelids, symblepharon, ankyloblepharon, eversion of the lower lip, dragging the chin down to the chest, obliteration

of the nostrils and loss of the nasal alæ or the ears are frequent occurrences from burning.

Scars may become rough and irregularly elevated by an abnormal development of fibrous tissue, caused by what has been called hypertrophy of the scar. Keloid degeneration of scars is quite frequent in negroes, and takes place also in the white race. It occurs in the period of adolescence, not in the very young or the middle aged; and seems to be more frequent in scars left by

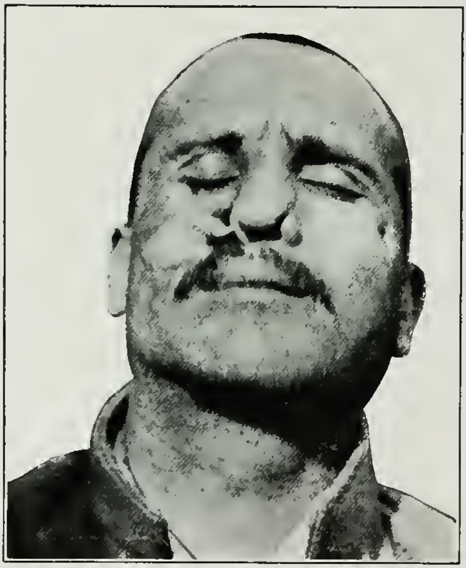


Fig. 135.— Another view of a late stage of disfigurement of cheek and nose from war wound. Probably suitable for prosthesis. (*British Journal of Surgery.*)

suppurating wounds. This curious form of tumor has been observed to arise not only from scars due to burns, syphilitic ulcers and other serious lesions, but from those left by leech-bites, acne pustules, herpes zoster, small-pox, and even fly-blisters. Moullin says that after small-pox the whole face may become expressionless by keloid transformation of the skin into a rigid mask of livid, nodular, and furrowed tissue.

Removal of keloid growths is often followed by prompt recur-

rence. The secondary tumor is not infrequently larger than the original one. Some surgeons have therefore advised against excision. This tendency to recurrence would seem to point to the necessity of a thorough extirpation by incisions placed at a considerable distance from the growth to be removed. Exposure to x-rays will often cause absorption of keloid scar tissue.

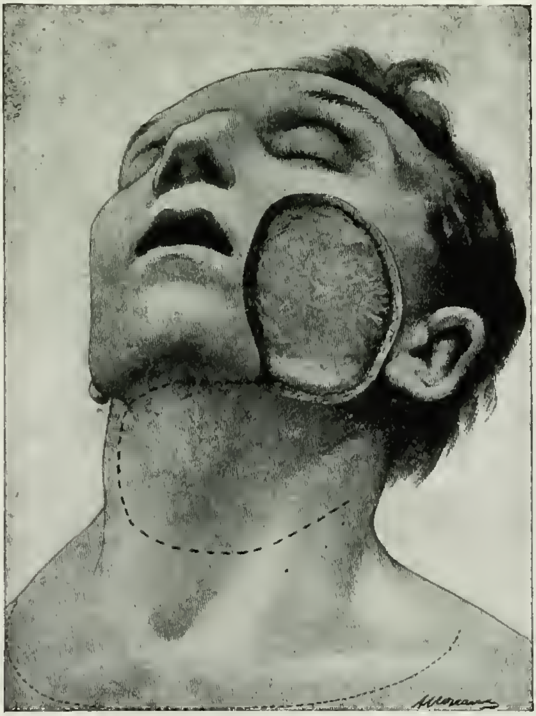


FIG. 136.— Superficial wound of cheek, left after excision of cancer. Outline of flap to close gap is shown by dotted line. The lower line crossing clavicle shows extent of undermining to gain integument to cover wound left in neck. (*Keen's Surgery, from Morestin.*)

Tiffany states the keloid tumors gradually soften and finally disappear. He believes that they will go away, or at least not increase much, after the patient has reached the age of twenty-five years. He reports the case of a girl of eight and one-half years who had received eighteen months previously burns of the face, arm, shoulder and breast. The scar was half an inch thick

and looked like a plate of cartilage. Dr. Tiffany declined to operate. When the girl was twenty years old the keloid condition had disappeared, and she had "a perfectly white, smooth, movable scar over the face." Observation of this and other cases has led Dr. Tiffany to the conclusion that operations for the relief of keloid deformity are unwise in the young of either the white or black race.

Fig. 137.— Cervical flap to repair cheek dissected loose. Same patient as Fig. 136. (*Keen's Surgery, from Morestin.*)

Thiosinamin has been advocated as a remedy, given by hypodermatic injection or by the mouth. It is probably without value.

If excision is adopted as the treatment, the incisions should go down to the muscular aponeurosis and be one or two centimeters beyond the apparent margin of the disease. In thus treating keloid of the face, the cuts should be so placed as to give the best approximation of the wound edges and to cause as little

dragging of the surrounding parts as possible. Union by first intention should be secured. If the gap is too great for coaptation, skin shavings or grafts should be grafted on the surface, or some plastic procedure should be adopted as is done after excision of malignant tumors of the face. The possibility of keloid change occurring in all the incisions must be remembered when

FIG. 138.— Integument of lower neck and clavicular region being undermined with scissors. Same patient as Fig. 136. *(Keen's Surgery, from Morestin.)*

such procedures are undertaken. Under some circumstances it may be better to wait for a few years for the natural softening and disappearance of the keloid tumor, or to adopt some of the non-operative means of treatment.

Now that the toxins of the erysipelas streptococcus and the bacillus prodigiosus are prepared for hypodermic use in the treatment of sarcoma, the surgeon might, as a primary method, treat

A. B.

FIG. 139.—A. Ectropion of lower lip and deformity of chin and neck from burn in infancy. Tongue is seen exposed by great eversion of lip. B. A later stage of reconstruction of mouth and chin. Head has been restored to normal position by plastic operations. (*Author's patient.*)

C.

FIG. 140.—By successive operations lip was reconstructed and inverted till boy could close mouth. The irregularities were later smoothed out. Ear, hand and neck also were restored to nearly normal shape.

keloid disease by subcutaneous injections of these bacterial products.

Cicatricial tissue and the healthy skin may be stretched by repeated and long-continued efforts to do so. Surgeons often pay too little attention to this fact in attempting to relieve deformity. If the scar and skin were subjected to previous systematic stretching, plastic operations would perhaps be more successful. Rubbing hard scar tissue with the fingers as in massage will hasten absorption of inflammatory products and may increase the pliability of scarred structures. A mild ointment such as petrolatum and adeps lanae may be used with the frictions.

Close approximation of wounded parts and union by first intention lessen the amount of scar tissue because they encourage regeneration of skin, muscle and fascia. Hence the wisdom, in war mutilations of the face, of prompt aseptic replacement of torn and displaced soft tissues, and the early reduction and fixation of mandibular fractures. The redness and thickening from inflammatory exudate, which remain after wounds have united, slowly disappear and need no treatment. Too much friction, especially if used without an oleaginous application, may cause irritation during the time of its continuance and perhaps thus render the scar red and more conspicuous.

The deformity occasioned by depressed scars is sometimes due to adhesion of the skin to underlying fascia or bone, sometimes to the puckered condition of the cicatrix, sometimes to the accumulation of thickened epidermis along the edges of the depression. The cicatricial tissue in some instances evidently extends down to the bone to which the skin at the bottom of the scar is, so to speak, anchored. Tubercular abscesses are apt to leave ugly scars because of the manner in which the skin over the abscess is thinned and devitalized before spontaneous evacuation occurs. Early operative evacuation of the puriform fluid or enucleation of the softened glands by a well-placed incision will often prevent the unseemly scarring. Scars from pustular acne become more disfiguring by accumulation of a horny layer of epithelium about them.

I have used carpenters' sandpaper of a coarse quality to rub down the irregularity of scars on the nose. It will cut away a

superficial stratum of skin and level inequalities of their surface. It must be done in an aseptic manner and most thoroughly, perhaps under local anaesthesia. The raw surface of skin will soon heal, if kept aseptic.

The unsightliness of depressed or irregular scars may be lessened by surrounding them by an elliptical incision, under-cutting the integument, abrading the surface of the scar, and then drawing the loosened skin over the cicatrix by neatly applied sutures. This device hides the uncomely scar tissue and elevates the surface a little. The linear cicatrix is very inconspicuous, if properly made. Puckered scars often are well treated by dissecting them out with a small and thin knife with a keen edge, undercutting the skin from the deep or superficial fascia, according to the depth of the scar, and drawing the smooth edges of the new wound accurately together with carefully placed sutures or clips. Paraffin may be used to elevate sunken tissues after separating them from underlying parts. It is injected when liquefied by heat and moulded into shape before it cools. Large depressions may be satisfactorily treated by implanting a graft of adipose tissue from the abdominal wall or thigh. The scar should be opened along the deep lines of depression. The knife should then undermine widely the skin, fascia and muscular tissue involved in the scar. This procedure makes a pocket within which to place a graft. The graft should be large enough to hold the skin above the surface of the face after sutures have been used to close the wound, because the graft will diminish in bulk later.

When depressed scars are due to loss of bone, grafts of cartilage or bone taken from costal regions or the tibia are available. Necrosis of the anterior wall of the frontal sinus is likely to produce such a deformity. I have used a tibial graft for such a disfigurement. Nasal depression after fracture of the bridge of the nose may be thus treated, if the surgeon thinks the defect not likely to be well removed by paraffin injection, or operative replacement of the fractured or dislocated bones. I am rather prejudiced, perhaps, in favor of paraffin prosthesis for the milder deformities. A piece of celluloid or a few minims of paraffin seem to most patients less formidable as a cosmetic agent than a graft of bone or cartilage taken from chest or leg.

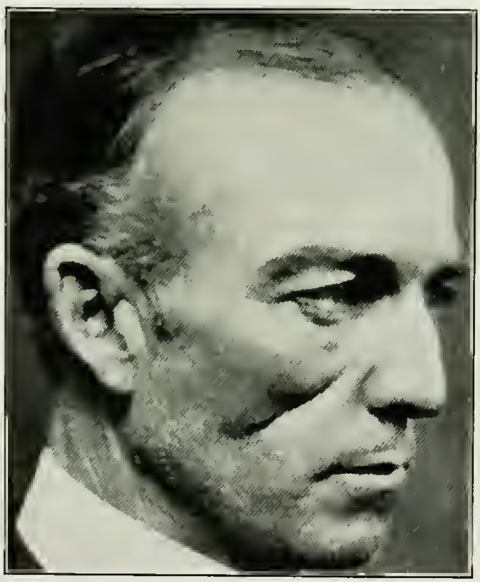


FIG. 141.—Deep adherent scar of cheek from wound due to kick of a horse. (*Author's patient.*)

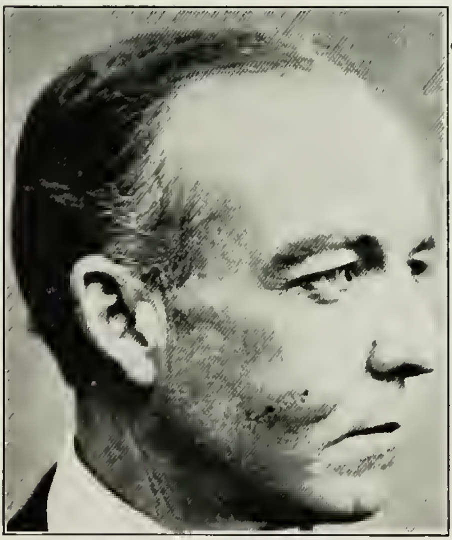


FIG. 142.—Condition two weeks after graft of adipose tissue from abdominal wall was buried under scar. Photograph taken before graft had time to shrink. (*Author's patient.*)

Contraction of scars following healing by granulation of large ulcerated surfaces, which have been caused by burns or wounds, distort the face so much that the surgeon's ingenuity is taxed to the utmost to obtain a satisfactory plastic restoration.

Pediculated flaps, free flaps or grafts, transferring of tension, transporting flaps by means of hand from abdomen or thigh, prosthesis, skin grafting and all forms of substitution are to be called to his aid. The discussions of plastic surgery of the different facial organs will give an idea of the usual devices. Each case will be found to have its own characteristics.

It is often wise to study, by frequent inspection of the patient, the nature of his facial deformity, before deciding what method of plastic repair promises most for successful surgical treatment. The surgeon will do well in difficult cases to make a model of the deformed nose, mouth or cheek, which he may inspect at frequent intervals, when he cannot see the patient personally. This is readily done by taking an impression of the surface of the distorted portion of the face with the modelling composition of the dentist softened by dipping in hot water. A thin layer of the compound previously warmed is spread on gauze, pressed down upon the region to be copied, hardened by cold water and then lifted from the patient's face. Thus is made a negative or mould of the portion of facial contour desired. Plaster of Paris cream may be poured into this mould, which has been greased to prevent sticking, and a model or cast of the deformed feature obtained. If the surgeon wishes he may tint this model to indicate skin, scar, mucous membrane and openings or sinuses. Such a representation of the deformity is then available at all times for study or for a record.

The same object may be obtained in a more artistic way by making the mould of plaster as death masks are made by professional sculptors. The simpler method is sufficient for surgical study as a rule. Sometimes it is sufficient to make a record of the deformity by soaking two or three layers of gauze in dental plaster and water mixture, and pressing them successively down upon the surface of the face and waiting for them to dry. The skin should be greased to permit easy detachment of the model after the plaster and gauze has set. It is sometimes convenient and wise to make a crude model out of modelling clay before

operating. This may be used to explain the proposed operation or for a record of work.

Sometimes scar tissue is disfiguring because it is much whiter than the surrounding skin. It has been suggested that such unpigmented scars may be colored by tattooing with pigments. It is difficult to imitate successfully the tint of the human skin.

FIG. 143.— Deformity from burn of eyelids, nose and mouth. Incisions to form lower lip shown.

Paschkis says that tattooing with cinnabar gives a satisfactory result when, after plastic operations on the lips, it is desired to give the intense red of the normal mucous membrane. The pigments now used in tinting the prosthetic masks worn after military mutilations might be of value for coloring the whitish scars.

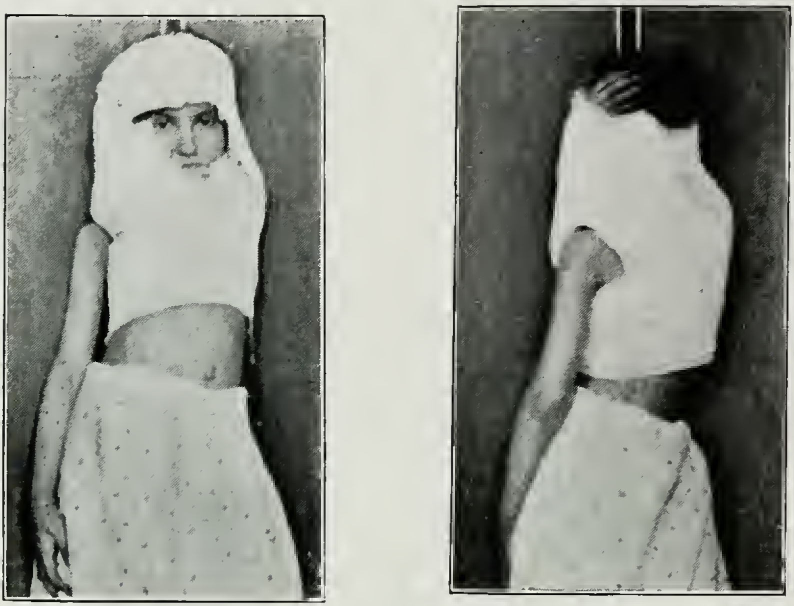


FIG. 144.—Method of applying gypsum splint when making lower lip from abdominal flap attached to hand and then transported to face. (*Roberts.*)

CHAPTER XIX.

TRAUMATIC FISTULES AND SINUSES.

Fistules occur as a result of wounds of the parotid salivary gland and its ducts. The possibility of establishing on the face such an abnormal exit for the saliva must be remembered when operating in the region in front of, or below, the ear, whether for the primary treatment of an injury from projectiles or for reconstruction of a scarred surface.

Suppuration from any cause in this part of the face may give rise to a similar salivary fistule by establishing an abnormal communication between the parotid gland tissue and the cutaneous surface, behind the proximal end of the parotid duct, or at any point in its course. The line of this duct is from the middle of the lobe of the ear towards a point midway between the ala of the nose and the corner of the mouth. The duct ends at the anterior edge of the masseter muscle; at that spot it dips inward towards the oral cavity, perforating the buccinator muscle and mucous membrane obliquely and entering the mouth as a slit on a papillary elevation opposite the second upper molar tooth. Salivary fistules also occur in connection with the sublingual and submaxillary glands and their ducts.

Salivary fistules are liable to be mistaken for sinuses due to necrotic bone or diseased teeth. The escape of transparent fluid, giving the chemical reaction of saliva and increased in amount during mastication will render the differentiation easy. Saliva escaping from an ulcerating lobule of the gland or the duct itself may burrow under the integument for some distance before it is discharged through an opening upon the surface; or the secretion so escaping from the gland may, if there is no cutaneous orifice, cause the formation of a cystic tumor. Bryant saw in three patients parotid salivary fistule situated behind the angle of the jaw. Agnew says he has seen a congenital salivary fistule situated on the anterior part of the helix of the auricle. It seems possible that this may have been a branchial fistule, mistaken for a salivary fistule. Mason speaks of subcutaneous rupture of the duct of the parotid gland from traumatism, causing emphysema-

tous swelling of the face and neck. An instance of nine or ten minute salivary fistules situated over the parotid gland is recorded. I once saw a patient with obstruction of the parotid duct who had a transudation of fluid on the skin over the duct. It was not tested for the salivary reaction.

Fistules of the face occur subsequent to suppurative inflammations with necrosis within the frontal and the maxillary sinuses, and after disease of the lachrymal sac and gland. The history of the case and the location of the cutaneous orifice will usually indicate the pathological condition underlying the disfiguring lesion, though the opening may be situated at quite a distance from the original disease.

Fistulous tracts running through the cheek or neck into the mouth are uncomely, and may result from suppuration about the roots of diseased teeth or subsequent to fractures of mandible or maxilla. In such dental inflammations care should be observed to prevent external pointing of the abscess. Hot applications should not be applied externally. Early incision of the gum, removal of the filling from the diseased tooth, or drilling into the pulp cavity will often relieve intense pain and prevent external disfigurement. Oral fistules due to sloughing of the buccal tissues are not common.

Sinuses are not infrequently found in the face because foreign bodies have remained embedded in the tissues after gunshot wounds and other injuries. Mason refers to a case in which a piece of a tobacco pipe three inches long had been embedded in the cheek for years. Necrotic bone from phosphorus poisoning, or syphilis, and tuberculous or actinomycotic abscesses will cause deformity by reason of the suppurating sinuses and their irregular cicatrization. Imperfectly erupted or impacted teeth dying within the jaw cause cloacae in the bone and sinuses in the overlying tissue.

Many years ago I removed, by chiselling through the outer wall of the mandible, an unerupted molar tooth lying horizontally within the body of the bone. The old woman came to the Woman's Hospital for treatment of sinuses of years' standing near the angle of the jaw.

The treatment of fistules and sinuses depends on their cause. Dead bone and foreign bodies must be removed and the resulting

scars made as comely as possible by well-selected incisions. The depressed and irregular cicatrices that sometimes occur from spontaneous or operative openings may be dealt with as suggested under cicatricial distortions.

Fistules of the parotid duct are seldom closed successfully until the current of saliva has been diverted into the mouth by constructing a free opening in the mucous membrane of the cheek. The exact position of the oral opening is not important, if it is so made as to remain sufficiently patulous to always conduct the saliva into the mouth.

If there is danger of cutting the duct in operations on the face, its position may be made distinct by inserting a bristle or small probe into the duct from its orifice, opposite the second upper molar tooth, before the facial incisions are made. If the duct of the parotid gland has been accidentally divided in operations of the face, the device advised by Moullin to prevent the formation of a salivary fistule may be adopted. He directs that the wound be extended into the mouth, and catgut suture passed through the mucous membrane of the cheek and the adjacent wall of the duct on each side and knotted on the oral surface. The skin is then closed and covered with collodion. The purpose of this operation is to establish an opening into the mouth at the point of injury to the duct.

When a salivary fistule exists on the cheek and cauterization has failed to obliterate the cutaneous opening, an operative procedure is demanded. Horner's method consists in cutting out a large disk of the diseased tissues with a saddler's punch carried through the entire thickness of the cheek. The circular hole left is closed externally with cutaneous sutures, while the saliva escapes from the end of the duct into the unclosed opening on the oral surface of the cheek. A seton may be passed through the external orifice, carried obliquely into the mouth, and worn until a large internal opening has been established. The outer opening is then closed as in Horner's more expeditious method.

Salivary drainage into the buccal cavity above the fistule may be established in some instances by carrying a thread, by means of a curved needle, around the duct from the mucous surface of the cheek without perforating the skin. The ligature is then tied within the mouth and allowed to ulcerate through the duct and

the mucous membrane, thus forming a fistulous opening within the mouth above the point at which the cutaneous fistule is situated. The saliva necessarily escapes from the opening nearer the secreting gland; and that is the intra-oral one. The cutaneous opening is then closed by paring the edges deeply and suturing. The incisions to freshen the edges of the fistule may be carried through the entire thickness of the cheek.

Sometimes a flap operation may be demanded to close the opening securely. The placing of the thread around the duct is performed with more accuracy if a bristle, filiform bougie, or the canaliculus probe used by ophthalmic surgeons, has previously been introduced into the duct to show its exact location. In some cases the duct can be advantageously slit up with scissors from the mucous surface and the edges of the mucous membrane lining attached to the inner wall of the cheek with sutures in such a manner as to prevent closure of the new orifice. Another method is to dissect a portion of the duct free from the surrounding structures and to turn its end into the mouth by a plastic operation. The incisions are made principally or entirely on the mucous surface.

When minor operations are not efficient in closing a duct fistule, more elaborate procedures become necessary. These should not be attempted too early in the case, because, if the distal end of the salivary duct is patent, fistules due to lateral wounds may usually be cured by simple means. Fixing the two jaws together with wires and avoiding foods of a stimulating nature which cause great secretion of saliva may, if accompanied by external pressure or cauterization, obtain spontaneous cure of the opening. The most difficult fistules are those which have occurred from wound or ulceration close to the gland itself. Such cases may require a plastic repair. This is to be attempted by using the mucous membrane upon the internal surface of the cheek to construct a tubular extension from the proximal end of Stenson's duct into the mouth. Sometimes a clean cut section may be repaired by immediate anastomosis or suture similar to that used in division of the vas deferens. In the plastic operations it may become necessary to excise a portion of the masseter muscle and part of the ramus of the mandible. This gives access to the site of the injury and aids in the operative manipulations.

If the wound is farther from the gland the duct may be dissected out of the deep tissues and its proximal end turned into the mouth through a new opening in the buccal mucous membrane.

As a secondary result of infected wounds of the face, a septic parotitis may arise. This occurs also secondarily to some of the eruptive diseases, but is probably more frequent from infection being carried into the duct from infective mycotic conditions of the mouth and surrounding tissues such as wounds of the face and oral cavity. Applications of ice to the parotid region may relieve incipient suppurative infection. Thorough cleansing of the mouth or removal of any obstruction, such as calculus or foreign body, in the oral end of the duct may abort a beginning suppurative inflammation. If, however, the process proceeds in an active manner, incision of the gland may be required to evacuate pus, or to relieve tension due to pressue from the fluid within the parotid fascia. This should be made freely through the skin in front of the ear and any pockets of pus opened by blunt dissection with hemostat or probe.

Salivary fistules connected with lobules of the secreting gland and not with the duct of the entire gland may be remediable only by dissecting out the portion of glandular tissue supplying the saliva.

Fistule of the frontal sinus due to suppuration within that mucous cavity may occur in the forehead, or under the eyebrow near the root of the nose. These fistules can seldom be closed until free drainage downward into the nose has been established; though sometimes a free opening made with a drill or nasal trephine into the sinus under the inner end of the eyebrow may suffice for irrigation and drainage. To accomplish drainage into the nose a free incision should be made in the forehead, parallel if possible to the cutaneous wrinkles of that region, necrotic bone removed and the sinus thoroughly curetted and disinfected. A drill should then be driven from the sinus downward into the nasal chambers and a rubber drainage tube left in the canal thus made. It is probably wiser to at first leave the tube protruding through both the frontal opening and an anterior naris.

Daily irrigation of the sinus and drainage canal with normal salt solution or mild antiseptic lotions should be made. When the discharge of pus has nearly ceased and the drainage down-

ward is well established, the tube may be shortened so that it does not protrude from the forehead, and plastic closure of the frontal opening may be attempted. This is to be done by simple approximation, after freshening of the margins of the orifice, or by a flap of skin.

An osteoplastic flap might be chiseled from the surrounding periosteum and bone and laid over the opening by twisting or turning upside down, if it is deemed wise to attempt to reconstruct the anterior wall of the frontal sinus. It often requires prolonged treatment of the frontal sinus with antiseptic and astringent washes to cure the suppurative inflammation of the lining mucous membrane. Until this membrane is comparatively healthy, successful plastic closure of the fistule is hardly possible. A bone graft cut from the tibia may be planted under the skin to relieve the disfigurement due to the depressed scarring.

In intractable cases of frontal fistule, it is proper to make a large incision and chisel away the entire anterior wall of the sinus. This operation gives access to the diseased mucous membrane and may enable the surgeon to bring the suppuration to an end. The consequent scarring will have to be corrected as far as possible by subsequent cosmetic operations. In one of my patients the pus had burrowed and made a tract through the bone under the eyebrow. This caused ectropium and exposed the cornea, which became inflamed from want of protection. I was obliged to turn a flap from the forehead downward to correct the ectropium and protect the cornea.

Fistules of the antrum of the upper jaw are rare, because purulent accumulations are apt to be evacuated spontaneously into the nose or mouth rather than upon the cheek. Empyema of the antrum should be treated by catheterization through the normal opening in the middle meatus of the nose; by perforation with a drill introduced into the nostril and carried through the bone below the inferior turbinated bone; or by boring through the front wall of the upper maxilla just above the canine tooth. If a molar tooth is diseased it may be extracted and access obtained through the tooth socket. A good tooth should not be sacrificed. The opening thus made in the mouth gives good drainage downward and should be kept open by a drain tube or

plug for several weeks. Drainage is necessary before any fistule on the cheek can be expected to close. Chronic suppuration may demand thorough exposure and drainage of the accessory sinuses of the nose by chiseling away the bone after the methods of Killian and others.

Fistules of the lachrymal sac demand dilatation of the nasal duct and sometimes the introduction of a soluble or a metal style. Soluble styles of rawhide have been satisfactory in my hands as dilators of the nasal duct. Downward drainage must be maintained and the mucous membrane brought to a fairly normal condition before frontal, antral, or lachrymal empyema can be with certainty cured. Any coincident nasal disease tending to keep up the trouble should be efficiently treated.

CHAPTER XX.

REPAIR OF TRAUMATIC DEFORMITIES OF THE MOUTH AND LIPS.

Avulsion of soft tissues and pieces of broken bone may cause great defects in, and displacements of, the margins of the mouth. Distortion of the mouth and lips and deficiencies of the lips and cheeks not infrequently occur as the result of cicatricial contraction after slow healing of burns, wounds, or sloughing. Sometimes ugly disfigurements remain after the removal of malignant or other tumors, as after accidental injuries.

The sloughing following burns of the face often causes frightful facial disfigurement. This may involve nose, eyelids and cheek as well as the mouth, because these structures are so near together that a severe burn of the face is apt to destroy contiguous tissue. When the slough has separated from the underlying parts a deep ulcer remains. This should be at once covered with autogenous skin grafts, if possible. Otherwise the contraction of the fibrous formed tissue from the granulations covering the wounded surface may close orifices or drag the lips and eyelids out of position.

OCCLUSION OR CONTRACTION OF THE MOUTH.

The treatment of cicatricial contraction and complete atresia of the mouth is based on the same general principles. The lips must be divided and abnormal adhesions prevented, especially at the corners of the mouth, by suturing the mucous membrane to the skin. A horizontal incision must be made outward from the orifice representing the mouth. The mucous membrane of the cheeks must then be drawn and sutured into the end of the incision so as to prevent reunion of the edges of the cheek wounds. It may be best to form at first an opening in the cheek with its margin lined with mucous membrane. In some cases a V-shaped piece of the cheek may be removed with the point of the V extending outward, and mucous membrane and the skin may then be stitched together along the side of the V

A circular mouth due to cicatricial contraction might be en-

larged by cutting vertically from the center of the opening downward into the tissues covering the front of the chin. The mouth might then be enlarged laterally by sliding upward the structures from the front of the jaw or inserting a flap from the anterior surface of the neck and chest. This flap might be long enough to permit the end to be folded upon itself in a manner to

FIG. 145.— Deformity of mouth and arms from burns.
(*Spellissy, from Keen's Surgery.*)

FIG. 146.— Flaps from back to relieve deformity shown in Fig. 145.
(*Spellissy, from Keen's Surgery.*)

have the inside and outside covered with skin. Mattress sutures could be used to hold the raw surfaces of the flap in contact. Such a flap sutured in the gap made by splitting the contracted mouth would enlarge the opening. The skin on the inside of the new lip and cheek would gradually assume the characteristics of mucous membrane. The inner part of the flap should be formed from skin having little beard growing upon it. In complicated cases, where only hairy skin was obtainable, the hair could be

destroyed by electrolytic puncture of each hair follicle or perhaps by repeated exposure to x-rays before the flap was cut. Various methods are available for plastic construction of lips and cheeks from arm, hand and abdominal skin. These should be employed in repair of contraction of the mouth after injuries due to gunshot traumatisms.

Moderate contraction of the mouth after wounds may be con-

Fig. 147.— Result after operation on case shown in Fig. 145.
(*Spellissy, from Keen's Surgery.*)

sidered negligible unless there is disfigurement or abnormal adhesion of lips to the gums. The cheeks and lips are so supple and so mobile under the influence of the muscles that speech and mastication are very little restricted by moderate diminution of the orifice of the mouth. Some increase in size may be obtained by frequently wearing an oval stretcher of metal or celluloid similar to the lip portion of Brophy's gag. Chewing gum for long periods of time will loosen up moderate cicatricial stiffness

of lips and cheeks after injury or operation. Massage is also a valuable adjuvant in establishing softness and mobility.

Everted lips may be turned inward by excising a horizontal wedge-shape piece, beginning at the mucous surface and extending through to the lower surface of the skin, but not cutting through the skin. If the latter is divided, an external linear scar will be made. This, however, is not important if the correction of the deformity makes such external wound necessary.

The great eversion of the lower lip due to burns may be improved by a V-shaped incision with its base corresponding with the edge of the lip. This allows the skin to be slipped up toward

FIG. 148.— Deformity from burns of the hands. (*From Keen's Surgery.*)

the mouth and the lip raised until it lies against the gum and teeth. The hypertrophied mucous membrane due to exposure may in some cases require excision. This will aid in drawing the lip upward and inward. The upper lip is perhaps more apt to be dragged by cicatricial influences obliquely upward than to be everted like the lower lip under the same circumstances. It may be displaced downward by a similar sliding of V-shaped flaps from the cheeks; it may require the insertion of a thick flap made from the cheek to fill the gap left after the displaced portion of lip has been freely separated from adjacent structures. The V must embrace all the everted portion in its base and must

be long enough to permit sufficient sliding. The nearness of the nose limits the freedom in making the flaps, which is possible in the chin and neck for the correction of everted lower lip.

Whole thickness skin grafts from the thigh or abdomen or pedunculated flaps from arm or hand may be required to reconstruct lips lost by sloughing from burns or other causes.

The head may be flexed on the chest by scar contraction; and thus growth of the jaw and lower part of the face may be impeded in children. Sometimes restitution can be obtained by a

FIG. 149.— Eversion and hypertrophy of lower lip by scar contraction. Lines show V incision to slide the lip upward and the oval wedge to be excised to lessen bulk of lip.

V-shaped incision of the chest and neck and sliding. At other times it is best to take two long flaps from the scapular regions of the back. These are brought around the front of the neck like a collar to meet in the middle line after a dissection has been made to release the head and allow it to be held erect. This method was used in the boy shown by the accompanying photograph.

After removal of malignant disease or sloughing at the corner of the mouth or of the lips it may be necessary to construct a

portion of or an entire lip or to fill in an opening left in the cheek. A small opening in cheek may be closed by a crescentic flap turned up from side of neck.

If the cheek is largely destroyed, it may be best to dissect a U-shaped flap from the neck, turn it upward and thrust it through a buttonhole-like incision made along the outer margin of the jaw. In this manner the skin surface of the flap is within the mouth and adhesion does not take place between the surface of the flap and the raw surface of the gums. The outside of the flap, which makes the cheek, is covered with skin grafts or shavings either at once or at a later time. This operation is very valuable when cicatricial ankylosis of the jaws complicates the loss of the tissue of the cheek. If the skin of the neck is covered with beard, the hair may be gradually removed by electrolysis or the x-ray before the flap operation is performed.

The cheek is not infrequently adherent to the gum when sloughing has occurred from the abuse of mercurials as a medicine, exanthematous fever, or other causes. Sometimes it is necessary to dissect the cheek loose from bone above and below and from the edge of the masseter muscle behind, and make intra-oral flaps of mucous membrane, which can be inserted on the inside of the cheek or on the gum so as to prevent the apposition and consequent adhesion of live raw surfaces. Care must be taken to avoid injury to the parotid duct and motor nerve which lie on the surface of the masseter. The thrusting of a U-shaped flap from the neck through a buttonhole may be much better.

REPAIR OF DEFECTS OF MOUTH, LIPS AND CHEEKS.

War wounds, operations for malignant disease, syphilitic ulceration and sloughing may destroy the upper or lower lip and render the formation of an entire lip necessary to relieve the deformity. This operation is called cheiloplasty.

If the lost portion of the lip is near the angle of the mouth, the tissue to reconstruct the organ may be taken from the other lip, the cheek or neck.

Fortunately, the branches of the facial, or motor, nerve after leaving the mastoid foramen and traversing the tissues of the parotid gland, run rather deeply in, or close upon, the upper surface of the masseter and other muscles of the face. If they

had their course close under the skin in the adipose superficial fascia they would be more subject to division in plastic surgery of the cheeks.

Deep incisions in certain parts of the face will cut the branches of the seventh nerve, which gives the motor supply to important muscles. The branches which go to the orbicular muscle of the eyelids should be avoided, because a motor paralysis will prevent the patient closing the lids. The cornea thus exposed is liable to become the seat of ulceration from irritation by particles of dust. A line, running from the lobe of the ear to the central point of the lower edge of the orbit, gives the direction of the facial nerve and the motor filaments going to the orbicular

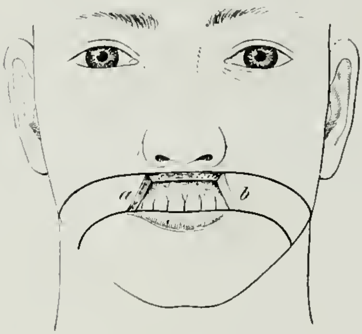


Fig. 150.

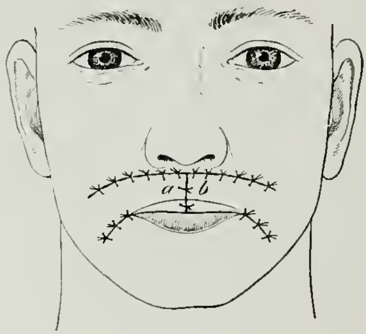


Fig. 151.

Restoration of upper lip.

muscle. The main portion of the nerve runs through the parotid gland and is not touched by superficial incisions. Cuts on the anterior part of the face should not go back farther than the line mentioned. This will enable the patient to retain control over the muscle which closes the eyelids.

Palsy of the buccinator and the orbicular muscle of the mouth may occur if the filaments from the facial nerve to the buccinator and orbicular of the mouth are damaged. These nerves and those which run to the upper lip and nostrils, supplying the zygomatic and elevator of the angle of the mouth, are situated a considerable distance below the surface. A superficial flap may be made in this part of the cheek without interfering with the motor control of these muscles. Operations which attack the

Bullet wound of left axilla, passing through mandible with exit at side of nose. (*Courtesy of Dr. Hunter W. Scarlett.*)

Frontal flap twisted to close opening in region of lachrymal duct.
(*Dr. H. W. Scarlett.*)

Depressed scar of cheek was dissected out, flaps undermined and sutured.
(*Operator Dr. H. W. Scarlett.*)

Result after healing of the plastic operations.
(*Dr. H. W. Scarlett.*)

whole thickness of the cheek between the eye and the mouth necessarily damage some nerve filaments. The resulting cicatricial stiffness, however, prevents the muscles of the opposite side of the mouth dragging the repaired structures out of position. The characteristic deformity of facial paralysis is therefore avoided after deep operations on the cheek. The motor nerves to the masseter and muscles below the mouth are less likely than those in the upper region of the face to give conspicuous deformity after injury. Avoidance of them in operation is therefore not so important.

Free undercutting of the flaps, in order to make them mobile,

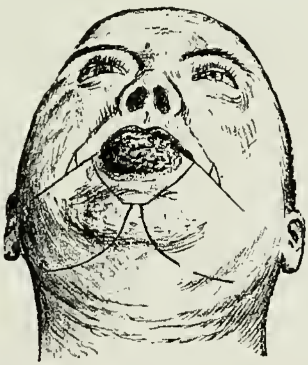


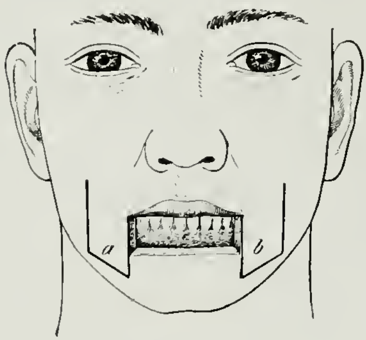
FIG. 152.—Dowd's incisions for making lower lip after excision of labial tumor.

divides few nerves of importance, except in the region of the eye as above stated. The surgeon should recollect that on the side of the face the branches of the facial nerve after emerging from the parotid gland lies close to the masseter, temporal-facia and zygomatic arch. The lines already given supply the information requisite to prevent the surgeon dividing the parotid duct and the important motor nerves. The hints as to the danger zones are well described by V. P. Blair.

In cutting a flap from the side of the temple for reconstructing the cheek, the anterior temporal artery and accompanying veins may be retained in a cellulo-cutaneous pedicle or temporarily transferred in a mass of superficial fascia to a jumped flap. This insures good circulation. The vessels with surrounding fascia

may be buried by making an incision through the skin, so that they may lie under it, as in a tunnel in the subcutaneous tissues, between the flap and its original site. The skin along the edges of the cut for burying the vessels should be undermined so as not to compress the vessels. It may be sutured over the vessels.

Blair advises that the fibers of the platysma myoid be included in the flap. It will be recollected that this muscle varies in thickness and lies practically within the superficial fascia. Beneath the muscle will be found the external jugular vein, the branches of the superficial cervical plexus of nerves which should be protected from injury if possible. Wounds, however, of either of



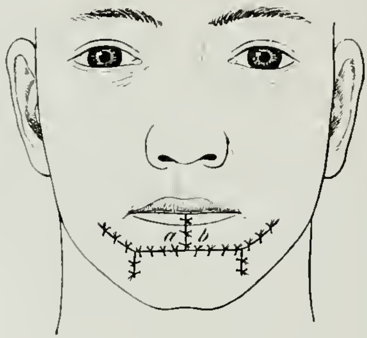


FIG. 153. FIG. 154.

Diagram of method of making lower lip from tissue over mandible.

these nerves or of the external jugular vein are of no very serious import at the hands of surgeons used to operative work.

The two appended cuts show an incision for a case of this kind, and the result. The flap from the upper lip was drawn downward and twisted into place so as to successfully close the gap.

Defects in the margin of the mouth from loss of parts of cheek or lips require plastic operation to restore the lost portion. The edges of the lips should be given at least a semblance of mucous border; and the fissure at the two corners of the mouth should, when the patient is quiet, show neither a smiling nor sorrowful expression. The nerve supply from the facial nerve should be damaged as little as possible by the surgeon's incisions.

Stomatoplasty, the restoration of a mouth; cheiloplasty, the

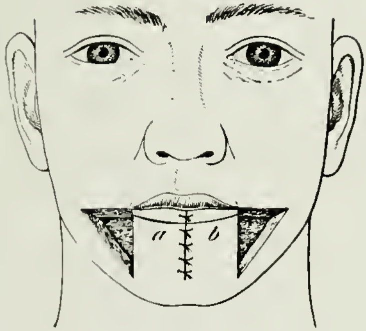
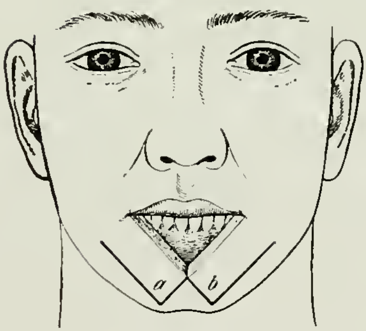


FIG. 155. FIG. 156.

Restoration of whole lower lip.



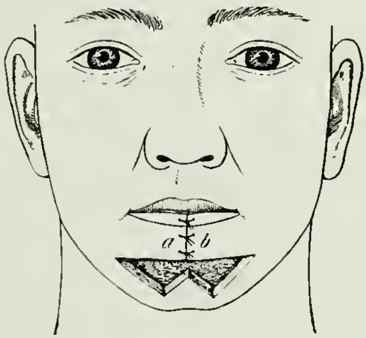
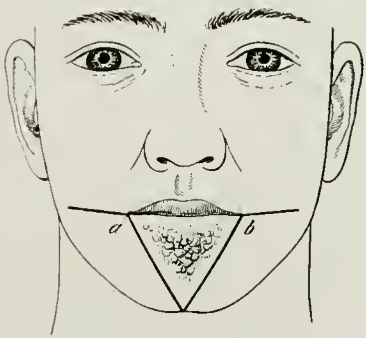


FIG. 157. FIG. 158.

Operation for restoration of lower lip.



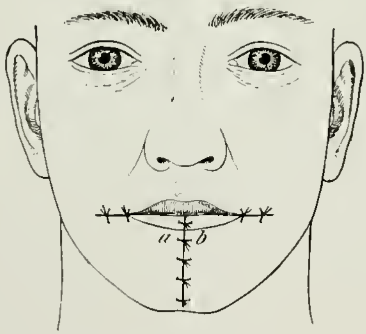


FIG. 159. FIG. 160.

Restoration of lower lip.

formation of a lip; and meloplasty, the reconstruction of the cheek, are almost infinite in variety, because total and subtotal losses of all kinds occur in these regions. The surgeon has to combat also multitudinous complicating conditions which have an influence on the choice of method.

Cheiloplastic operations are required to replace lips or to restore mobility of lips adherent to the gums. They build up a portion of a lip or an entire lip lost by destructive injury, or gangrene, or operation. Burns of a necrotic degree cause various grave distortions of these organs from scar contraction, which need operative reparation. These are cheiloplasties also. Unless the structures surrounding the mouth have been destroyed

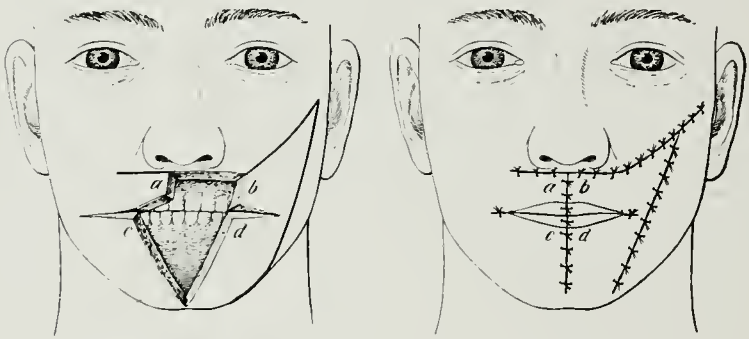


FIG. 161. FIG. 162.
Restoration of both lips.

extensively by gangrene or converted into fibrous cicatrix containing a limited blood supply, much can be done by well-planned plastic operations. Repeated operations are necessary, and much patient confidence in the surgeon is required on the part of the sufferer from the deformity. Months must elapse before the reconstruction is effected.

A not infrequent disfigurement is eversion of the lower lip from burning of the face and neck by fire or caustic chemical substances. These necrotic burns destroy such deep masses of skin and fascia that the chin is tied down by the scar to the chest and the lower lip is everted until the saliva may drip over its exposed and thickened mucous surface. The hypertrophied mucosa may cause the everted lip to resemble a protruded tongue.

Gunshot wounds of the lower part of the face, with or without fracture of the mandible, frequently require reconstructive operations in this region. Phosphorus necrosis of the mandible, abscesses, tumors of dental origin, and undershot mandible may supply the surgeon with operative opportunity. Several classic methods are shown in the diagrams here inserted. Much ingenuity is often required to obtain the results that are demanded by the mutilating injuries of the battlefield.

New lips, made from the integument of the chin or neck or from brachial or palmar flaps, when necessary, may be lined with mucous membrane taken from the inner surface of the cheeks or upper lip. Usually this is not demanded, because the

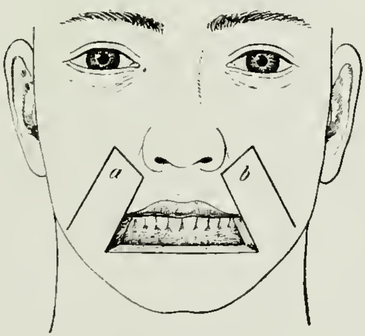


Fig. 163.
Another method of making lower lip from cheeks.

skin, when turned in so as to be continuously exposed to the secretions of the mouth, is converted into a pseudo-mucous membrane. Raw surfaces of fascia and muscle undergo a similar transformation under the same influences.

Deficiencies of the lower lip may be repaired by inserting flaps from the upper lip and cheek or from the neck.

These illustrations, many of which are from Szymanowsky, will give an idea of the various forms of pedunculated flaps that may be employed when the new tissues are obtained from the vicinity of the mouth. Often it may be found, especially in deformity after the sloughing of the burns, that no sufficiently vascular and elastic tissue can be secured for this purpose from this region. Then free flaps of skin cut from the thigh or

abdomen may be tried, as suggested by Wolfe and Krause for grafting. Sometimes brachial flaps with pedicles employed after the Tagliacozzi method of rhinoplasty or flaps from thigh or abdomen transported to the face, after first planting them in the tissues of the hand, may be preferred.

Cicatricial deformities of the face from burns often demand many operations on chin, lips, nose, eyes and ears, and all varieties of flaps are used. Long flaps from the back or chest or both may be carried around the neck to allow the head to resume its natural attitude on the neck and shoulders.

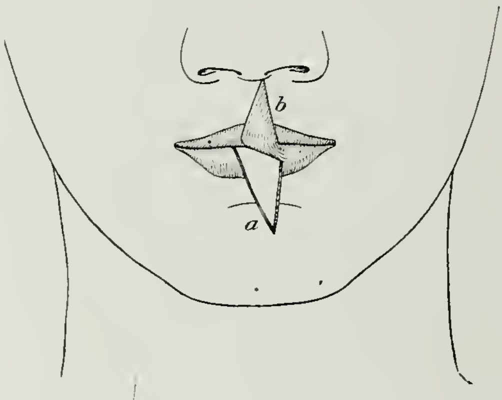
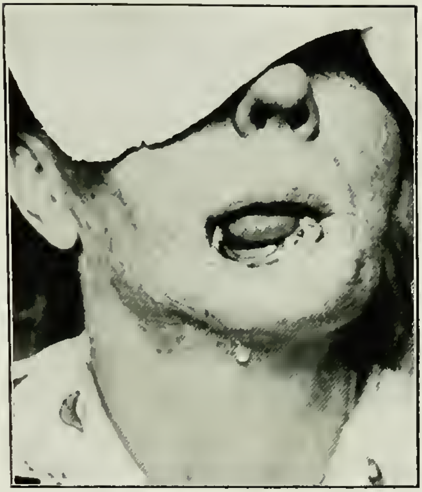


Fig. 164.— Diagram to show method of transferring wedge flap from lower lip when it is too bulky and the upper lip needs tissue to increase its breadth. After the wedge (b) has grown fast in the incision (a) made in the upper lip, the pedicle supplying it with blood is severed. The wound (a) in the lower lip is closed with sutures at the time the transfer is made. Plastic correction of a tight lower lip may be made in a similar way from an upper lip and the adjacent cheek.

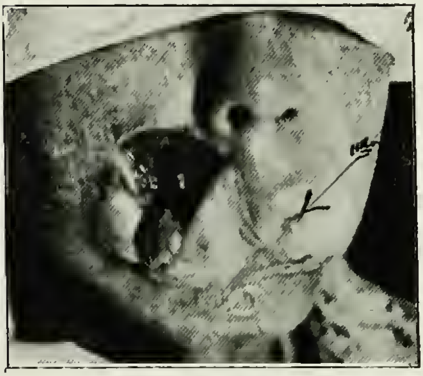
Construction of the cheek, or meloplasty, may be required after gunshot wounds or other traumatisms carrying away the wall of the buccal cavity. In these cases it may be necessary, if the mandible be partly lost, to have an appliance adjusted to the teeth to hold the remnants of the mandible in place during cicatrization. This may consist of caps cemented to the upper and lower teeth of the side opposite to that lost, having hooks upon them. To these hooks rubber bands may be adjusted so as to hold the fragments of the mandible in proper position in relation to the middle line of the face. Many forms of splint for accom-



1. Loss of part of mandibular alveolus and of lower lip from necrotic infection arising in a tooth socket. (*Author's patient.*)

2. Partial reconstruction of lower lip has been obtained by sliding submandibular flaps towards gap in the oral border. Heavy lines show proposed incisions for further operations to increase height of lower lip.

3. Lower lip has been still further rebuilt, but mouth is still unable to retain saliva or conceal tongue. Heavy lines show design of next operation, which will swing triangular section of upper lip and cheek into a gap made in the lower lip by dissecting out tough scar.



4. Flap from right cheek and upper lip has been turned down and stitched into the rawed cleft made in the lower lip. An arrow shows opening into the mouth by which patient took liquid food for three weeks. The pedicle of the flap is the whole thickness of the upper lip.

5. Arrow shows new tissue left in lower lip to increase its height and width, after the pedicle was divided and the remainder of the labial flap restored to its position.

6. Patient now has enough lower lip to retain saliva and conceal tongue. Only slight plastic modifications still needed.

plishing this object are shown in the chapter describing methods of treating gunshot fractures of the mandible.

An artificial jaw may, if needed, be made of vulcanized rubber, and even a cheek plumper may be constructed and worn to fill out the collapsed cheek. Bone grafts may be used to rebuild the jawbone, or cartilage grafts may be employed for the purpose. The fragments of the mandible should be held apart as a rule until the tendency to separation has disappeared, by either an interdental splint, or spreaders. After several weeks the bones will remain apart and the bone or cartilage graft can be more readily kept in position until it becomes part of the mandibular arch or is replaced by new bony tissue.

The obliquity of the mouth due to palsy of the facial nerve may be improved somewhat by excising an elliptical portion of the tissues of the skin and careful suturing of the skin edges. Anastomosis of a part of the spinal accessory nerve to the distal portion of the paralyzed facial nerve has been used to give power to the muscles of the face supplied by the inactive nerve trunk.

After removal of part of the entire thickness of body or ramus of the mandible by gunshot wound, operation, or necrosis, there remain two separate pieces. Displacement occurs as a result of muscular pull and a V is formed of the arch. This prevents normal occlusion of the dental arches. The two fragments should be held apart by some spreading device for several weeks until the tendency to displacement disappears and marked deformity does not occur. Westlake made an intra-oral splint before operation in such a case, and after excision held the remaining portion of bone in proper position by it. It consisted of gold caps fitted to the teeth of the upper and lower jaw and an attached removable spring. This held in normal position the portion of the mandible which remained, and was discarded in a few months when the muscles ceased to exert a displacing tendency. A vulcanite cheek plumper was then adapted to fill out the collapsed cheek, due to the absent portion of the jaw.

For cicatricial ankylosis of the jaw, one may cut away the scar tissue within the mouth, and then dissect a flap of skin and fascia from the neck which is tucked through a vertical incision made in front of the masseter. Thus a non-contracting skin flap is put inside of the mouth and the ankylosis cured. This method

deserves consideration in cases where puckering of the lips and cheeks has occurred from intra-oral adhesions and scar contraction. A long flap of skin and fascia may be thus turned into the mouth and its end folded outwards at the commissure of the lips, so as to reconstruct the angle of the mouth and the outside of the cheek at that point. This is similar to the method of Delbet for reconstructing the cheek and the corner of the mouth with a doubled skin flap from the cheek or neck.

INJURIES OF THE FACIAL NERVE.

When the facial nerve has been divided external to its exit from the petrous bone, causing facial paralysis, anastomosis with the central end of the spiral accessory nerve or the hypoglossal nerve is an approved operation. Such anastomosis, however, is impracticable if the injury to the facial nerve has occurred within the aqueduct of the petrous bone. The operation is performed in the following manner:

A bullet entering the upper part of the neck may cut off the facial nerve within the canal or very close to its emergence through the sterno-mastoid foramen. Facial paralysis gives great deformity, and difficulty in mastication arises from flaccidity of the buccinator muscle. Morestin has reported a case in which the trunk of the facial nerve was injured at its exit by a perforating bullet. The missile made a wound completely through the face, cutting the right lingual nerve, as well as the facial nerve on the same side, and damaging the infraorbital nerve of the opposite side of the face. He performed two operations under local anaesthesia for the facial palsy. The first consisted in making a slightly curved incision of seven centimeters along the anterior border of the temporal fossa, descending upon the malar bone. A bundle of fibers was separated from the anterior edge of the temporal muscle but left attached to the muscle at the lower end. This flap was fastened with buried sutures of fine catgut to, and beneath, the fibers of the orbicular muscle of the eyelids lying underneath the skin of the lower lid. The point of attachment was carefully selected so that the fibers of the temporal muscle, by traction, might act to close the eyelid. In other words, the muscular flap from the temporal muscle was used to give power to the lower section of the orbicularis.

By a second operation, Morestin endeavored to give power to the buccinator muscle by a similar use of fibers of the masseter. An incision 5 cm. long was made under the angle of the jaw, exposing the anterior border and part of the external surface of the masseter. The buccinator was then uncovered, retracted and fixed by a series of buried sutures to the anterior edge of the aponeurosis and to the superficial fibers of the masseter. The points of suture were chosen by testing the effect of traction by forceps on the paralyzed buccinator.

These operations, while far from bringing about restoration of function, at the same time caused to a large extent the disappearance of the asymmetry of the face when the muscles are at rest; when the muscles are in action the asymmetry increases, but is not nearly so marked as previously. The patient cannot completely close the right eye, but, by comparison with the previous condition, a great improvement is seen, the eyeball being better protected, the lachrymation having ceased, and the conjunctival irritation having disappeared.

Morestin has devised this muscle transposition on the lines used by othopaedic surgeons in paralytic conditions of the limbs. It is similar in design to the Roberts method of using fibers of the frontalis in paralytic ptosis of the upper eyelid. Perhaps a nerve graft from sciatic nerve might be used to repair facial nerve.

Injuries to other motor nerves will be found discussed on page 430.

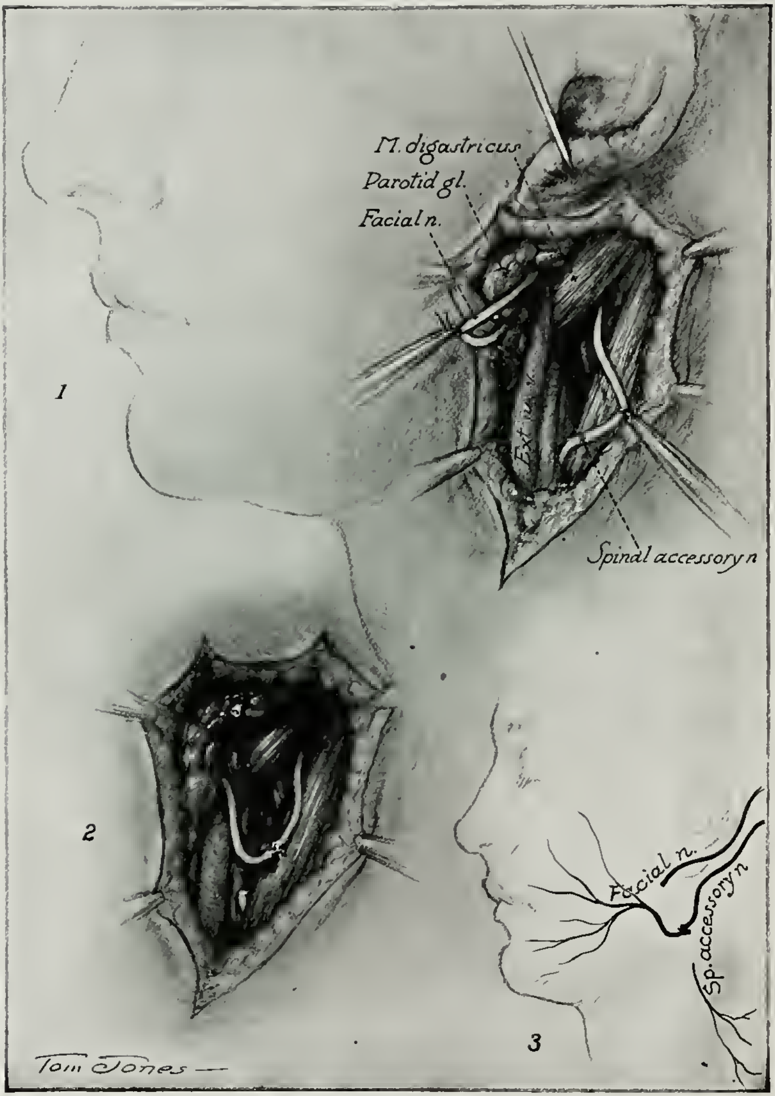


FIG. 165.— Anastomosis of facial nerve with spinal accessory.
(*From A. E. Halstead in Surgical Clinics of Chicago.*)

CHAPTER XXI.

REPAIR OF DEFORMITIES OF EXTERNAL NOSE.

The external nose may be carried away by shot wound or be lost, partially or entirely, as a result of septic ulceration or necrosis. The necrotic process, if extensive, may destroy not only the nasal bones proper, but also involve the supporting septum of the cartilaginous external nose. The cicatricial contraction after such widespread inflammatory destruction may produce a deformity very similar to that which is seen in the sunken nose of syphilis, in which the interior bones and cartilages disappear and leave scarcely more than an irregular orifice in the center of the face.

Fractures of the bones and cartilages of the nose and dislocations of the same structures have very similar symptoms, and require almost identical treatment. The cartilages and bones forming the framework of the nose are united with each other, and with their neighbors, by sutures at which normally there is no motion. If a dislocation occur between a bone of the nose and an adjoining bone or cartilage, the rupture of the suture-like connection is very similar to a fracture of bony tissue itself. There is also preternatural mobility at the line of junction because the bond of union has been torn. A fracture may show no preternatural motion if the fragments are impacted. Immobility may also be present in dislocations. The nasal or ascending processes of the two maxillae form part of the lateral walls of the upper portion of the nose, and are quite often involved in crushing injuries of the nasal framework.

Fractures of the nasal bones are due to direct force. The fragments are not subject to secondary displacement from attached muscles, but may, especially when comminuted, be somewhat changed in position by attempts at blowing the swollen nose or by sneezing.

A common form of fracture of the nasal bones is a transverse lesion near the middle, in which the lower fragment is driven backwards at an angle with the upper fragment. The lower portion of the nasal bones at their median suture is supported by

the quadrangular cartilage of the septum. When the fracture just described occurs, the quadrangular cartilage may receive the force of the blow, and be driven backward with the lower portion of the nasal bone which has been broken off. As a result the cartilage may be bent or fractured, or be dislocated from its attachment to the upper border of the vomer; or its lower anterior angle may be torn loose from the membranous portion of the septum near the lobule of the nose, or from its connection with the maxillary bones at the anterior end of the vomer.

In some fractures of the nasal bones the comminuted fragments are driven directly backwards so as to lie behind the nasal processes of the maxillary bones. Instead of a fracture, or coincident with the fracture, a luxation may occur between the nasal bone and the nasal process of the maxilla. The nasal bones, while remaining attached to each other in the median line, may be dislocated and occupy a somewhat similar relation to one or both maxillae. If the blow is received on the side of the nose rather than the front, the two nasal bones may be luxated together, the outer edge of the nasal bone on the side of the injury being driven under the border of the maxillary process, while the outer edge of the other nasal bone is displaced on top of the maxillary process. In severe injuries the nasal processes of the superior maxillary bone may be fractured as well as the nasal bones themselves.

The frontal bone and the horizontal plate of the ethmoid bone may be involved in severe fractures of the nose in such a way that the fragments are driven into the cranial cavity. In such cases impaction may occur. Meningitis or cerebritis may develop as a result of infection due to the injury. Even when impaction does not take place, infection may occur through fissures in the frontal and ethmoid bones. The frontal sinus is very likely to be opened. This complication increases the probability of infection in such severe fractures at the root of the nose. The cribriform or horizontal plate of the ethmoid is not likely to be fractured, when the force injuring the nose spends its strength upon the lower third of the nasal bones. It is the perpendicular plate of the ethmoid bone that then bears the brunt of the injury.

Fractures of the nasal septum, which is partly bony and partly cartilaginous, occur in connection with fractures of the nasal

bones. When the force is received upon the upper part of the bridge of the nose it is the ethmoid that is likely to be fractured. It is the quadrangular cartilage of the septum which is liable to be injured when the traumatism acts on the lower part of the dorsum of the nose. The line of fracture is perhaps more frequently horizontal in its general direction than vertical, and a luxation of the cartilage from the vomer is more common than from the ethmoid. In many instances, however, the fracture is associated with dislocation of the cartilage from the vomer or the ethmoid bone, and may assume more or less the character of a triangular fracture-dislocation. The fragments of the cartilage or of bone and cartilage may override so that the line of the bridge of the nose shows a marked depression in the region of the lateral cartilages.

It is essential that all recent injuries of the framework of the nose be promptly and skillfully treated, so that deformity from unreduced or carelessly replaced tissues may be averted. Injuries which are insignificant, so far as danger to life is concerned, may leave distortions of the outline of the nose or obstructions to breathing of great importance.

Many fractures and dislocations of the nose are accompanied by wounds of the mucous membrane or skin; but, notwithstanding this open condition of the bony or cartilaginous injury, grave infection is unusual. This relatively aseptic healing is due to the abundant blood supply of the injured parts and the cleansing of the mucosa by the secretions from the lining membrane of the nasal cavities. Necrosis is not very usual even when the bones and cartilages have been greatly comminuted. Severely damaged soft tissues will often survive, if cleansed and sutured into their normal relations.

Penetrating wounds of the face with bullets, pieces of shell casing or shrapnel, inflict war injuries to the nose which are apt to become infected. Loss of the bones and cartilages from secondary necrosis are therefore common.

Plugging the nasal cavity on one or both sides may occasionally be required to control bleeding. This is best done with successive pieces of aseptic marine sponge threaded on a strong cord and pushed into the nose through the anterior naris until the space is firmly filled. Marine sponge is better than gauze or

cotton. The plugs should not be left in position more than two days. Then the nasal cavity may be flushed with a mild antiseptic solution, and repacked if necessary.

The rapid swelling which accompanies severe injuries of the nose soon obscures deformity in its framework and causes many fractures and luxations to be overlooked. Anaesthesia with nitrous oxide or ether should be employed when a systematic examination is prevented by pain. Local anaesthesia with cocaine may be sufficient. Reflected light from a forehead mirror is an essential in many cases, because persistent obstruction to respiration from unreduced septal injuries may lead to mouth breathing and its attendant changes in the mandible and throat. Saddle nose, bent nose, twisted nose, and occlusions more or less complete of one or both sides, are frequent witnesses of unrecognized or untreated nasal injuries.

When displacement has been found, readjustment of the fragments or of the luxated structures must be promptly effected. Unless the reduction of the fracture or dislocation is accomplished within about eight days, perfect adjustment is difficult. Fractures are firmly united in from two to three weeks. As a rule, there is comparatively little callus. The masses of deforming bone found in old unreduced nasal fractures are largely made up of comminuted fragments, which have not been replaced at the time of the traumatism, and the consequent uniting callus.

The character of the injury and the form of displacement are to be determined by palpation of the exterior with the fingers, assisted by a rigid slender instrument within the nose for counter-pressure. Inspection of the nasal cavities will be of service and may be supplemented by exploration of their interior with a probe. Cartilages may be broken and then spring back into position so that no displacement of fragment remains. The mucosa may show scarcely any damage except a red line over the break in the cartilage.

Emphysema of the eyelids and cheeks may indicate that the accessory sinuses have been opened by the fracture. Imperfect drainage of tears from the eye to the lower nasal meatus is presumptive evidence that the nasal duct has been obstructed by swelling of its lining mucous membrane or by a distortion of its bony wall by reason of associated fracture of the maxilla. Escape

of cerebrospinal fluid from the nose indicates that the floor of the anterior fossa of the cranium has been invaded by lines of fracture through the ethmoid or the frontal bone.

It is well to recollect, when examining the interior of the nose for septal fractures, that they occur most frequently in the posterior two-thirds of the quadrangular cartilage or the anterior half of the bony septum.

Fractures of the nasal bone with or without fracture of the adjoining nasal processes of the maxillae usually produce a depression in, or a flattening of, the bridge of the nose. Broadening of the nasal arch as well as flattening, and lateral deviation with or without angularity, may also occur. Dislocations of these bones produce similar deformity. Dislocation of the lateral cartilage from the lower margin of the nasal bone causes a hollow in the dorsum of the nose near the junction of the middle and lower thirds. Fractures and dislocations of the septal structures may accompany the lesions of the bony bridge of the nose and give deviations of the nasal partition. Both nostrils may be obstructed by the oblique position given a septal fragment.

Elevation or other restoration of the displaced fragments of the osseous arch of the nose can best be accomplished by introducing a narrow steel rod through the nostril. Its inner end should be thrust upwards under the nasal bone of the corresponding side. The surgeon then pushes the displaced bone or fragment into position by the exercise of considerable force. The fingers of the unoccupied hand of the operator are kept upon the cutaneous surface of the bridge of the nose, to mould the fragments into place and to determine the exact result of the internal pressure. When the bones or their fragments are impacted over or under the maxillary process, the counterpressure of the fingers on the outside is an invaluable aid in facilitating reduction. The steel rod must be narrow enough to go up to the top of the space between the nasal bone, the ethmoid plate, and the process of the maxilla. There is very little room there.

The manipulations to restore a displaced septum may be performed by a fingertip inserted into a naris, but usually a strong flat blade forceps is better. The blades should be parallel. The front part of the septum should be grasped with the forceps, of

which one blade enters each naris, and should be pulled forward. At the same time the posterior end of the fragment in the grasp of the forceps should perhaps be tilted upward by depressing the handle of the forceps. This maneuver combined with lateral movement, which may not always be required, will restore usually the line of the nasal bridge from forehead to the tip of the nose, and get the obstructing fragment of cartilage or bone into the middle of the cavity of the nose. Some form of bougie should be passed into the nostrils to insure complete patency on each side of the septum.

If sufficient time has elapsed since the injury to cause partial union of the displaced fragments, strong lateral movements must be made with the forceps to break up the fibro-osseous connection. If such rupture is not possible, resort to the chisel and saw becomes necessary.

The corrected position of the nasal bones, lateral cartilages, and septal structures is to be maintained by nasal pins, or internal splints, and perhaps by external pads attached to forehead bands. There is, as a rule, little tendency for the replaced fragments of the bones of the nasal bridge to drop inwards or be displaced in other directions, unless the patient handles his nose or blows it violently. When such a tendency exists, because of great comminution, a small strip of gauze packing may be used to fill the intranasal space directly under the bony ridge on the required side of the septum. Instead of this the tie beam method of support may be used. This consists in thrusting a steel pin or drill transversely through the nose under the bony bridge. It may go through the nasomaxillary sutures or through drill holes in the nasal processes of the maxillae or between the comminuted fragments of the nasal bone itself. Two or three days are long enough to leave the pin in position.

Instead of the pin or drill a rubber thread may be carried through the drill holes, and lead shot protected by rubber disks may be clamped on its ends. This device will give lateral pressure and permit swelling of the soft tissues without injuring the skin or disturbing too much the desired lateral pressure. The intranasal rubber thread will stretch during swelling and contract as the swelling decreases. Thus will ulceration of the skin from pressure of the shot be averted.

Old unreduced fractures and dislocations require osteotomy or refracture, and readjustment. Much may be done by dividing cartilage and bone from within the nose. The operator punctures the mucous membrane in the necessary places, and by thrusting small saws or chisels under it reaches the bone or cartilage to be divided. The overlapping soft parts may be detached from the bones and cartilages by the free use of a tenotome. When necessary, small external incisions may be made to admit a small saw or chisel or a tenotome. These often need no subsequent suture to close them. To uncover more extensive areas incisions and flaps may be made with small sharp knives. After the bones have been divided and the readjustment has been completed, fine sutures of linen or silk restore the cutaneous surface. The scars soon disappear, especially if the cut in the skin has been made obliquely to the surface.

Sometimes saddle noses, due to fractures, can best be corrected by subcutaneous paraffin injections. Instead of using hot paraffin, cold or more or less solid paraffin may be employed, as in other cases of sunken bridge, if the dangers of embolism are feared. This material is best injected with a syringe having a piston driven by a screw attachment and a needle of large calibre.

In old uncomplicated lateral deviation of the bony bridge of the nose, Mosher makes a small incision in the skin at the outer border of the lower part of the nasal bone. With a chisel about one-eighth of an inch wide he cuts this bone from the ascending process of the maxilla. By slipping up the skin this can be done through a very small incision. He then turns the chisel at right angles and cuts the nasal bone loose from the frontal. This detachment is made on both sides of the nose and must be complete so that the bony nasal bridge is freely movable. It is returned to its normal position in the median line and held there by some form of external splint. Modelling compound or superimposed layers of adhesive plaster will usually be sufficient.

When the lateral deformity involves the cartilaginous as well as the bony bridge, the septal cartilage is usually bent and therefore occludes the naris on one side. Mosher says that when a perpendicular fracture makes a knuckle in the quadrangular cartilage, this prominence should be dissected out submucously. He stops removing the cartilage a quarter of an inch from the

top of the cartilaginous bridge. If the upper lateral cartilage is displaced, it is removed by dissection within the nose. When these intranasal procedures are completed, the nasal bones are chiseled loose as described above and returned to their normal median situation. There may remain a protuberance, due to the prominence of the nasal process of a maxilla, from which a nasal bone has been chiseled loose. This is cut off with a chisel, entered through the cut made to get access for the nasal osteotomy, and then is shoved down towards the interior of the nose.

Sometimes there remains lateral deformity at the point where the bony bridge and the cartilaginous bridge join. The skin should be cut at this point and a chisel used to separate the quadrangular septal cartilage from the under surface of the tip of the nasal bone. If this maneuver is not sufficient to allow the operator to straighten the nose, a half inch incision should be made downward and backward into the perpendicular plate of the ethmoid. Then a straight nose may usually be obtained by modelling. Proper retentive appliances should be employed for two or three days.

It is essential that the military surgeons should be on the alert to restore wounded nasal structures to the normal position as soon as possible after the infliction of the wound. The occurrence of septic infection may not be as common or as serious in its secondary results in the nose as in the mandibular region. It nevertheless is to be averted by prompt and efficient sterilization with early closure of war wounds. Complicating lesions of the brain, eyes and upper jaw are not infrequent in gunshot hurts of the nose. Under such circumstances trouble is very liable to supervene. The nasal bones, when fractured, but not involved in infection, unite very promptly. This means that deformity may be great if proper relations of bones and cartilages are not early reestablished.

To restore the crooked nose to its natural shape requires that all resiliency be taken from the distorted structures. The greater part of the triangular cartilage and the vomer may be removed submucously by cautious and painstaking separation of the muco-periosteum on both sides of the septum. The surgeon must work to have the organ very flexible and its bones and

cartilages and attachments under his control. It should then be twisted or moulded with the fingers into a somewhat over-corrected position, before the retaining pins or splints are adjusted. These mechanical splints should be used for about a week or ten days. The splints should be removed from the nostrils every day, and put back after the nasal chambers have been flushed out or sprayed with a mild aseptic or antiseptic solution. Sterile normal salt solution, the compound solution of sodium borate, and liquor antisepticus, are useful washes for this purpose. When pins are used for retention of the replaced nasal structures they do not need to be disturbed when the nasal chambers are irrigated or sprayed.

Local anaesthesia with cocain and adrenalin is sufficient in mild cases of deformity of the septum, but in more extensive operations general anaesthesia is necessary.

Injuries and septic necrosis subsequent to traumatisms may cause cicatricial saddle nose like that due to imperfect development of the nasal skeleton or somewhat resembling sunken nose caused by tertiary syphilis. In the latter a transverse furrow is produced between the bony ridge of the nose and its lobe; the tip of the nose is drawn upward from the line of the mouth, and the nostrils no longer lie in a horizontal plane, but look directly forward.

In marked saddle nose a piece of bone, costal cartilage, or celluloid, cut to accurately fill the hollow, may be slipped through an incision in the skin, which has been previously undermined, and left permanently in that position. The upper surface of the foreign substance is flat, the lower convex. Thus the line of the dorsum is changed and the saddle nose converted into one of a Grecian type. The shape to be given the bone or celluloid is determined by making a model of the surface of the disfigured nose. This is done by means of a plaster-of-Paris impression or mould in the manner adopted by dentists for making dentures. It is possible to lift up the periosteum and thrust the transplant or graft under this covering of the nasal bones. Cases of moderate deformity are satisfactorily corrected by paraffin prosthesis. Paraffin, which has a melting point of about 105° to 110° F., is sterilized by heat, and while fluid is injected with a sterilized and heated syringe under the skin so as to fill the hollow in the

dorsum of the nose. A large hypodermic syringe, such as is used in veterinary surgery, is all that is necessary. A few drops of the heated and therefore fluid paraffin should be injected beneath, not into, the skin; while still soft, this waxy substance is moulded with the operator's fingers. It promptly solidifies as it loses heat, and retains the form given it by the surgeon. The skin of the nose must be sterilized before the puncture is made

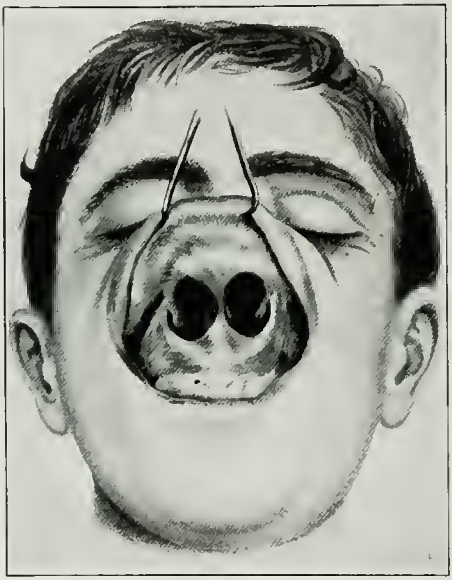


Fig. 166.— Rouge's method of gaining access to the internal nose by an incision within the mouth between the upper lip and upper alveolus, which permits elevation of lip and nose.

and the operator's hands must be sterile. During the injection the fingers of an assistant should be pressed firmly against the sides of the nose to confine the liquid paraffin to the dorsum. If this be neglected, the injected material will escape into the subcutaneous tissues of the cheeks near the eyes and produce great disfigurement. Only five to ten minims should be injected at first, according to the depth of the hollow to be filled. The needle should then be withdrawn and the effect of the modelling with the operator's fingers observed. If the paraffin hardens too

rapidly, hot cloths may be laid upon the nose and sufficient softening be thus obtained to permit a still further change in form by digital pressure. This secondary modelling is not possible if the melting point of the paraffin be over about 105° F. If examination shows that an insufficient quantity of the melted paraffin has been injected, a few more minims are deposited by inserting the needle in another place. This process may be repeated a number of times. The portion of skin raised is varied

Fig. 167.— Lawrence's incision for stragetic osteoplastic displacement of nose.

by changing the direction and depth of the needle point. Speedy work is required, because the paraffin soon hardens within the needle. This renders further injection impossible unless the syringe and its needle are dropped into boiling water again for a few moments. A rather large syringe with a screw nut to gradually force down the piston is very convenient. It retains the heat longer than a smaller syringe and enables the surgeon to force cool and semi-solid paraffin into the tissues.

The operation is rather painful, but is readily borne by the

average patient without anaesthesia. General anaesthesia may, of course, be used if desired. Local anaesthesia by infiltration is liable to conceal the deformity and deceive the operator. Sterile water may be injected to correct the deformity and thus become a guide to the quantity of paraffin needed to obtain the correct contour. A few hours later, after the water has been absorbed, an equal bulk of paraffin can be injected. The punctures, if made with aseptic precautions, need no dressing. The

FIG. 168.— Ollier's incision for stragetic osteoplastic displacement of nose.

patient should bathe the nose frequently with cold water or apply cold compresses to allay the inflammatory reaction due to the effect of the heat and tension on the soft tissues. In a few days the redness and feeling of pressure subside.

It is much better to introduce too little paraffin than to run the risk of depositing too large a mass. It is easy to repeat the procedure in a few days or weeks, if after the lapse of that time the inadequacy of the operation is evident. To remove paraffin causing an overcorrection necessitates a cutting operation and may leave undesirable scarring.

Embolism of the vessels of the retina is said to have occurred from particles of paraffin entering the circulation. As a result blindness has occurred. This unusual accident should be thought of as a possibility. It must be very rare. Pressure by the assistant's fingers along the side of the nose to confine the fluid paraffin to the dorsum may perhaps tend to prevent the occurrence of this calamity. Semi-solid paraffin would make this accident less likely.

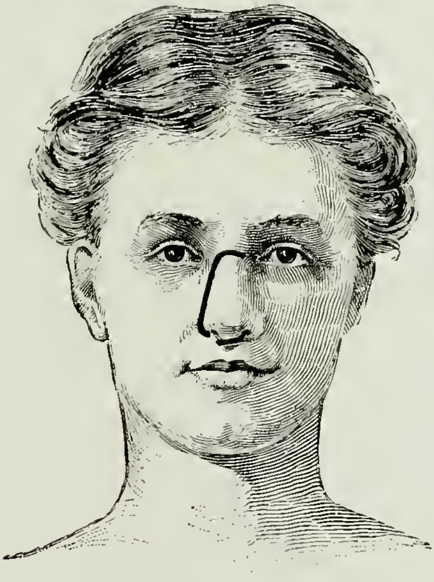


FIG. 169.— Boeckel's incision for stragetic osteoplastic displacement of nose.

When the nose is cicatricial, it is difficult to force the liquid paraffin into the fibrous tissue covering the bones of the nasal bridge. Openings may then be made with a small tenotome and the skin undermined to make a cavity to receive the wax-like material. This operation is a more difficult one than that just described and requires more care and skill.

The paraffin is best melted and sterilized in a small glass vessel placed in a hot-water bath. The water in the bath may then be used to sterilize and keep warm the syringe and needles. Small forceps and pads of gauze are used to handle the hot instruments. The patient's face and eyes should be protected from possible

burning from contact with the syringe or with hot drops of paraffin escaping from it, if very hot paraffin is used.

Bullets and other missiles lodged in the deep portions of the face and neck may require for their removal access to the nasopharynx and mouth and to the regions behind the mandible.

The military surgeon should be familiar with the strategic osteoplastic routes to these regions. By strategic operation is meant incisions through soft and bony structures, used as temporary means of reaching deep parts, which later are closed by sutures or nails to restore former contours. Strategic operations, which should leave inconspicuous scars, may be accomplished by turning aside large temporary flaps, making trapdoors in the structures overlying the foreign body, or securing room by dividing with a saw the mandible or zygoma to allow wide separation with retractors during the operation. The cellulo-cutaneous and osteoplastic flaps made to reach the interior of the cranium are good examples of this surgical expedient.

Resection of the bony palate may be demanded to reach deeply imbedded shrapnel material. The malar bone may be displaced and replaced to permit deep removal of the infraorbital nerve, the outer wall of the orbit may be cut loose as in Kroenlein's means of getting access to the deep orbital region.

Traumatic loss of the integument and cartilages of the nose below the nasal bones is repaired by plastic operations more easily and satisfactorily than deformities resulting from syphilis, gunshot injuries, or extensive operations for tumors. These causes of disfigurement often involve the bony and cartilaginous structures within the nasal chambers, as well as the projecting external nose. When the nasal bones constituting the bridge of the nose have been lost or the supports of the external cartilaginous nose have been destroyed, the reconstructive problem is much more difficult than when the cartilaginous nose has been merely sliced off with sword or knife.

The inherent trouble in all extensive nasal reconstructions is the obtaining of sufficient permanent projection from the surface of the face. It is an easy task to put a flat mass of skin and fascia in the region of the nose. It may not be very difficult to even give it at the time the prominence and general shape of a nasal organ. To maintain permanently the shape and prom-

inence of the new nose, despite the contracting power of scar-tissue, is the surgeon's real difficulty. To obtain nares which will remain patent and a columella which will resist deformity from postoperative contraction is often practically impossible. When the ulcerative process or gangrene from burns, frost-bite, or caustics has destroyed the cutaneous surface around the nose, it becomes necessary for the surgeon to transfer or transplant healthy tissues from other regions to replace the scar tissue.

Portions of nose accidentally cut off should be immediately replaced and sutured after aseptic cleansing. Their permanent union may sometimes be obtained if the parts are kept warm.

Rhinoplastic operations are important because of the cosmetic value of a comely nose. The psychic effect of a knowledge of marked facial disfigurement is sufficient to affect the patient deleteriously in both disposition and earning capacity.

Total rhinoplasty should mean reconstruction of the whole nose below the frontonasal suture, but the term is often used when the loss of the organ begins below the nasal bones. Pedunculated flaps for the reconstruction may be taken from the patient's arm, forehead, or cheeks. Brachial flaps require the arm and the head to be held in apposition by gypsum bandages or other retentive apparatus for about two weeks. A flap cut on the upper arm or forearm may be permitted with advantage to contract and thicken by cicatricial changes or be moulded somewhat into shape, before the arm and head are approximated and the flap sutured in the nasal region. Lexer has carved a nose from the condyles of an amputated femur, bored holes for nostrils, planted the bony mass under the skin of the forearm, and subsequently transplanted it upon the face.

The frontal method has the advantage that it requires no restraint in the patient's posture, and that strips of periosteum or bone cut with the flap from the forehead may be embedded in the new nose with comparative ease and considerable advantage. There are numerous modifications of these osteoplastic methods. The scarring of the frontal region is a disadvantage, but this may be minimized by aseptic methods and skin grafting.

In partial rhinoplasty pedunculated flaps are often taken from the cheeks. If cut in the direction of the nasolabial furrows, such flaps, even when large, leave comparatively little objection-

able scarring. The incidental diminution of the prominence of the cheeks increases the relative projection of the plastic reconstruction of the nose, and is, therefore, a cosmetic benefit. Superimposed flaps may be necessary in nasal reparations, in order to give to the structures sufficient thickness and rigidity to retain nasal prominence.

Free flaps of integument from the inner surface of the thigh or arm may be utilized, if careful asepsis is obtained and maintained during the transplanation and after-dressing. Such non-

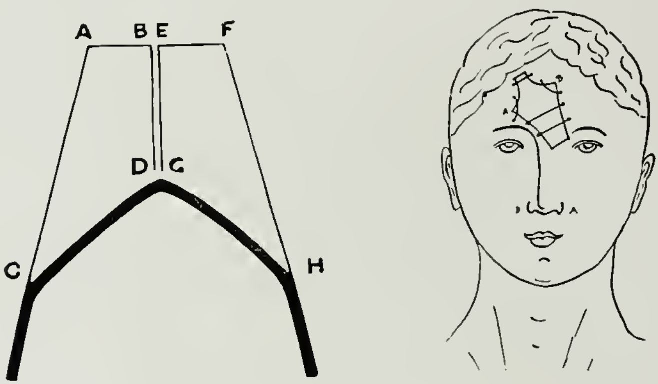


Fig. 170.— Diagram of Keegan's operation for rhinoplasty. The flaps C A B D and G E F H are dissected from surface of nasal bones and bent downward as if on hinges at C D and G H. The second diagram shows Keegan's method of cutting the frontal flap and applying the sutures to the frontal wound. (*From Keegan's Rhinoplastic Operations.*)

pedunculated flaps cannot be used with much hope of success when the raw surfaces or edges are subjected to direct communication with the nasal chambers. Infection is then too probable.

Portions of cartilage taken from the patient's ribs or ear, pieces of bone from the forehead, tibia, ulna, ilium, a finger or toe, may be implanted in the soft tissues used to repair the nose. These, if aseptic, become incorporated, and may give permanent rigidity to the newly made nose. Such organic implantations are preferable to inorganic implantations or supports of celluloid or metal.

The method of Keegan, whose service in India gave unusual opportunity for practical experience in dealing with mutilations

of the nose, is probably the best rhinoplastic operation, when the nasal bones and the skin covering them have been preserved. The operator first dissects, from above downward, two flaps from the surface of the nasal bones and turns these down as on a hinge at the lower border of the bony nasal bridge. This gives a cutaneous surface toward the open nasal chambers and a raw surface from the root of the nose to its proposed tip. An oblique frontal flap is then cut with its pedicle near the inner canthus of one eye, so that it may be nourished by the angular artery. The alae and columella are provided for in forming this flap.

FIG. 171.— Result of Keegan's method of rhinoplasty. (*Keen's Surgery.*)

The size and exact shape of this frontal flap have been previously determined by cutting a piece of rubber sheeting or a flexible leaf to meet the special requirements of the deformity. This is copied in paper and the paper fastened to the skin of the forehead before the knife which marks out the flaps is used. The flap is then raised, its pedicle twisted, and sutures are used to fasten it over the bared nasal bones and the turned-down flaps covering the opening of the nose. A pit is made above the middle of the upper lip to receive the projection forming the columella, and

the wounds on the side of the nose are deepened and lengthened to receive the edge of the flap from the forehead. The frontal wound is closed by sutures and with grafts made from any excess of tissue removed from the nasal or frontal flaps. Drain tubes are kept in the nostrils for a few days to maintain patency and the pedicle is divided in ten or fourteen days.

Instead of trimming away the median margins of the everted nasal flaps, which are voluminous, Henry Smith splits the remains of the nasal septum, inverts these median edges into the nasal cavity, and stitches them to the respective sides of the split septum. He thus creates a new septum and columella, and

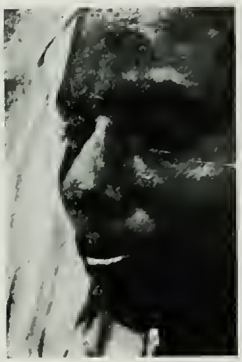


Fig. 172.— Patient operated upon by Major Henry Smith by his modification of Keegan's method. (*Courtesy of Dr. D. F. Keegan.*)

lines more of the interior of the new nose with skin. If the septum and columella thus made are not sufficiently rigid, a strip of cartilage, cut from the end of one of the patient's costal cartilages, might be subsequently thrust into the new partition to give it rigidity.

A valuable method of total rhinoplasty is that of Charles Nélaton. He excises nearly the entire length of the cartilage of the eighth left rib and trims its end for about 2.5 cm. down to a thickness of 3 mm. This strip of cartilage he notches where it is expected to make the point of the nose. Then he thrusts it into a horizontal tunnel between the bone and periosteum of the forehead. In two months the cartilage becomes vitally con-

nected with the surrounding tissues. The cicatricial borders of the nasal stump are then pared loose, making three flaps. These are turned downward and inward and are sutured together so as to close more or less completely the upper part of the gap left by the loss of the external nose. The raw surface of these flaps presents forward.

An irregularly quadrilateral flap is then cut from the forehead, with its pedicle at the inner border of the right eyebrow, containing the transplanted costal cartilage in its middle line. This flap is raised from the bone, carrying with it the entire periosteum and the implanted costal cartilage. It is twisted downward and

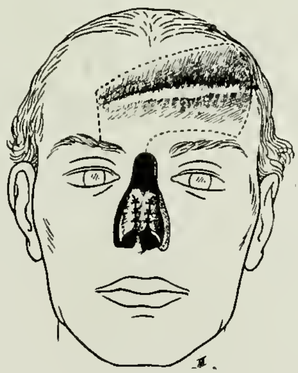


FIG. 173.— Charles Nélaton's method of rhinoplasty by implanting costal cartilage in forehead before using frontal flap.
(*From Nélaton and Ombrédanne.*)

sutured on top of the nasal flaps just mentioned. By appropriate modelling with stitches an acceptable nose, with alae, columella, and nostrils, is formed.

The frontal bone may lose a thin layer of its surface by necrosis, because its periosteum has been removed, but when granulation has occurred Thiersch grafts are applied, and the final scarring is said to be not very deforming.

In brachial rhinoplasty the flap for the new nose may be cut from the upper arm or the forearm, or a pedunculated flap from the thigh or abdomen may be grafted upon the hand and subsequently transported to the nasal region, just as if it had originally been formed from brachial tissues. The retentive appa-

ratus to hold the arm or hand close to the face may be made from bandages and gypsum or from leather and webbing. The patient may be fitted with such appliances and wear them for a time prior to operation, in order to become inured to the discomfort due to their use. The method of transportation by hand is of more

FIG. 174.— Gunshot injury repaired by frontal flap.
(Courtesy of Dr. H. W. Scarlett.)

value probably when partial rhinoplasty is to be done, because even it scarcely can give sufficient rigidity to form an acceptable organ in total rhinoplasty.

Schimmelbusch has devised a method in which he uses a large osteoplastic flap from the forehead and slides large areas of the scalp from the temporal regions to cover the denuded space. The bony flap is covered with Thiersch grafts and then reversed.

Some operators have employed both frontal and bracial flaps, superimposing one upon the other.

For the various deformities requiring partial rhinoplasties there are almost innumerable operative devices.

In subtotal loss of the organ, Charles Nélaton has sawed a long A-shape flap from the forehead and nasal margins, containing a

FIG. 175.— Result of plastic operation shown in previous figure. (*Dr. H. W. Scarlett.*)

plate of bone from the frontal bone and edges of the nasal and superior maxillary bones. This osteoplastic A-shape flap is slipped downward and bent into shape to make a nose in the nasal region.

Berdenheuer has devised a support for the anterior part of a new nose by incising the osteocartilaginous septum, if any re-

Fig. 176.

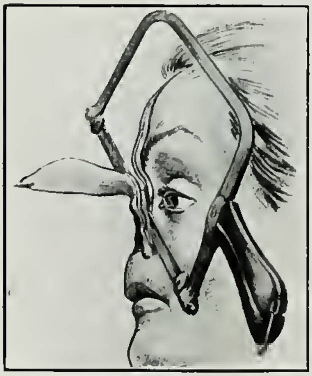


Fig. 177.

Fig. 178.

Figs. 176, 177 and 178.—Charles Nélaton's method of osteoplastic rhinoplasty in partial loss of the external nose. (*Nélaton and Ombrédanne.*)

mains, and turning forward a triangular flap, which projects beyond the plane of the face. On this support cellulocutaneous flaps are placed.

The method described by Cheyne and Burghard may be found valuable in some cases of saddle nose.

Noses in which depression of the bridge is great and especially those in which the skin is bound down by old inflammatory adhesions demand radical operative procedures.

Deformities from violent injuries, such as gunshot wounds causing avulsion, extensive fractures or chronic septic necrosis, with adhesions between the skin and the remains of the destroyed internal structures of the nose, belong to this class. They may

FIG. 179.

FIG. 180.

FIG. 181.

FIGS. 179, 180 and 181.—Schimmelbusch's total rhinoplasty by means of an osteoplastic frontal flap, followed by lateral sliding of the skin of the temporal regions toward the middle line. Triangular areas of skin are removed at 1 in Fig. 000 to permit apposition of the displaced temporal integuments. The new columella is made from the remains of the alae as shown in Figs. 000 and 000. In Fig. 000 the reconstruction is shown as it appears after the sutures have been applied. (*Fowler's Surgery.*)

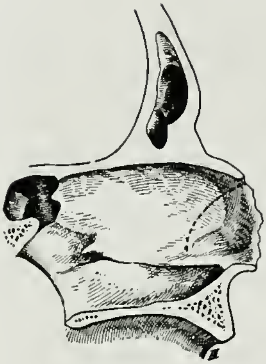


FIG. 182.

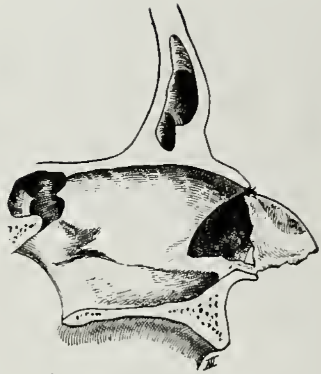


FIG. 183.

FIGS. 182 and 183.—Bardenheuer's method of supporting nose made of soft tissues with flap of septum turned forward.

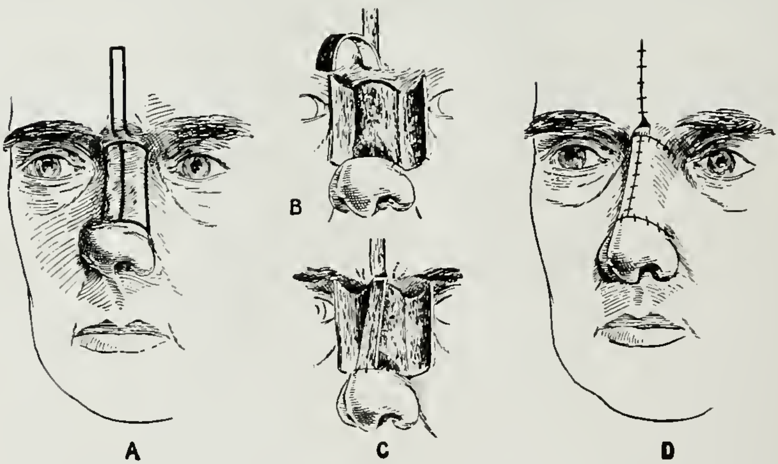


FIG. 184.—Restoration of the bridge of the nose by insertion of a strip of integument, periosteum and bone, from the middle frontal region, under the dorsal structures of the nose. *A*, shows incisions; *B*, shows dorsal structures opened like window shutters and the frontal osteo-periosteal strip bent downward; *C*, shows the new bridge in position; *D*, shows the wounds closed. (*Cheyne and Burghard.*)

resemble the sunken nose of necrotic syphilis. In some of these war deformities the skin of the nose should be detached from the bones by an inverted U-incision, and a frontal flap turned down and tucked under it. A piece of cartilage or bone may be incorporated in or between these superimposed flaps. Occasionally the tissues may be satisfactorily raised by undermining the skin with a tenotome and injecting semi-solid paraffin.

The worst forms require still more extensive operative reconstruction. When the middle area of the nose is drawn into the nasal chamber after loss of the bony and cartilaginous supports, the first step should be a deep cut across the sunken region in the transverse groove. This incision opens the nasal cavity and permits the lobule and alae to be displaced downward and forward into the normal position. This maneuver restores the prominence of the tip, or lobule, and makes the nostrils again lie in the horizontal plane. The next step is to fill the gaping opening between the lower margin of the bony bridge above and the replaced lobule and alae below. The tissues used to close this large orifice must be permanently thick and rigid. Flaps may be taken from the forehead or cheeks, or preferably from both.

I devised some years ago a method which answers well. The first stage consists in cutting a flap from each cheek near the naso-labial furrow. These are turned upward and inward to meet the median line and thus cover in the opening. The skin surface is toward the nasal chamber. After these flaps have been united and cicatrized, the irregularities at their base are corrected by incisions and sutures. The next major procedure is to make an inverted V incision from the middle of the forehead, the legs of which run downward and outward to points on the cheeks below the eyes. Just above the granulating surface on the former flaps, which closed the opening, a similar inverted V-shape cut is made. The apices of these two cuts are joined by a vertical incision in the middle line. This series of incisions marks out two rhomboidal flaps with their pedicles on the cheeks close to the sides of the nose. These flaps are then raised from the frontal and nasal bones and rotated downward over the cicatricial or granulating surface of the reversed cheek flaps, previously used to close the opening into the nasal chambers. The upper angle of the right flap is sutured to the base of the left ala,

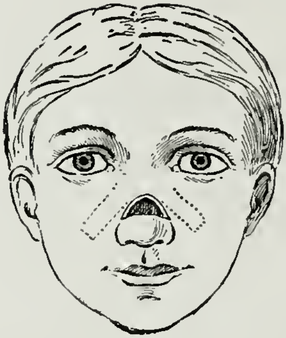


Fig. 185.

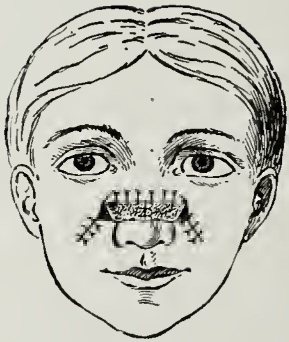


Fig. 186.

Fig. 187.

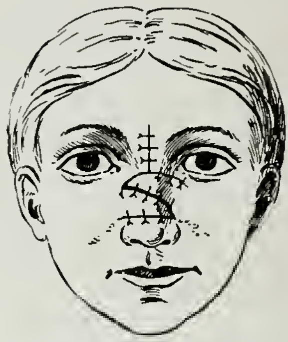


Fig. 188.

Figs. 185, 186, 187 and 188.—Roberts's method of operating upon the sunken nose by superimposed flaps from cheek and nasofrontal regions.

and that of the left flap is turned so as to reach across to a point near the inner canthus of the right eye. Sutures are employed to maintain the new relations of the frontonasal flaps, which have been laid upon the overturned cheek flaps; and the wound on the forehead is easily closed in a vertical direction. The scars are inconspicuous, and much rigidity is given to the tissues interpolated between the root of the nose and its lobule. The internal surface of the interpolation is lined with skin and so is the exterior.

For restoring the alae or the lobule of the nose, lost by wound, frost-bite, or burn, flaps may be taken from the cheeks, the lips, or even the chin. In some instances pedunculated flaps from

the arm or hand may be utilized, if the constrained posture of this procedure is not deemed undesirable.

The Bayer-Payr method cuts flaps from the sides of the chin and turns them up to make alae and columella.

The new alae may be lined with mucous membrane dissected from the nasal septum or inner surface of the lower lip or repaired with a flap from the cheek with the skin surface turned inward. Thiersch grafts, Krause free flaps, or small pedunculated skin flaps, thrust through buttonholes in the skin, may be

FIG. 189.— Tip of nose destroyed by caustic. (*Author's patient.*)

FIG. 190.— Lobe of nose made with pediculated flaps from cheeks.

used in this endeavor. The ala needs to be stiff enough not to collapse during inspiration. A slip of cartilage taken from the ear may be inserted, or scales of cartilage cut from the costal cartilage may be employed.

I have stiffened the columella of a soft nose by inserting a peg of cartilage cut from the tip of the eighth left costal cartilage. This gave the lobule the proper projection forward. The same thing was done by von Mangold in an endeavor to give support to the dorsum of a saddle or sunken nose, which needed rigidity of the raised or constructed area, between the nasal bones and its tip. The columella may be made from two vertical flaps cut from the upper lip, one on each side of the median line, involving only a part of the thickness of the lip. The entire thickness of

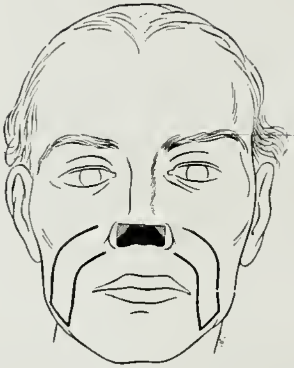


Fig. 191.

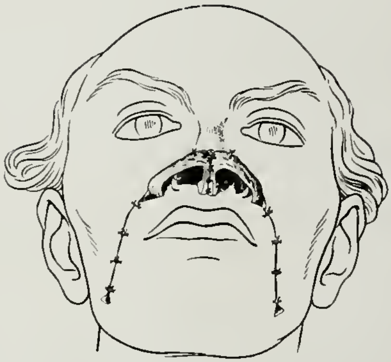


Fig. 192.

Figs. 191 and 192.— Lobule, columella and alae formed from flaps cut from lower part of the cheeks. At a later operation the base of the flaps are cut and the alae are set nearer the columella to make proper nostrils.
(*Bayer-Payr's method.*)

Fig. 193.

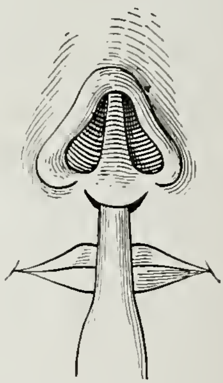


Fig. 194.

Fig. 193.— Columella, or lower part of septum, made from web of thumb.
Fig. 194.— Charles Nélaton's method of forming a columella by detaching with gouge the nasal spine and part of the vomer and bending it forward

the upper lip may be similarly employed for a single median flap. Longitudinal labial flaps may be chosen, or the tissues of the forearm or arm may be used, or that between the thumb and

FIG. 195.—Rhinoplasty by transporting toe to face through medium of hand. (*From Keen's Surgery.*)

forefinger may be grafted into the gap, by applying the hand to the chin for about two weeks. A portion of the nasal spine of the upper jaw may be chiseled loose and reflected upward, to give rigidity to the new columella which is to be constructed.

Kolle has closed defects in the ala of the nose by taking a free cutaneo-cartilaginous flap from the back of the ear. The flap is

Fig. 196.

Fig. 197.

Figs. 196 and 197.— To make ala of nose from cheek and upper lip.

Lip sutured early. Nose entirely blown away. Left eye destroyed.
(Dr. H. W. Scarlett.)

Scar in forehead shows place of implantation of rib cartilage for possible rhinoplasty. Cartilage was absorbed in forehead.
(Dr. H. W. Scarlett.)

Appearance after cicatrization of face and repair of upper lip, and glass eye in left orbit.
(Dr. H. W. Scarlett.)

Prosthetic nose of vulcanized rubber, tinted, attached to spectacle frame and held in nasal opening with a short hook.
(Dr. H. W. Scarlett.)

Vulcanized rubber nose attached to spectacle frame.
(Dr. H. W. Scarlett.)

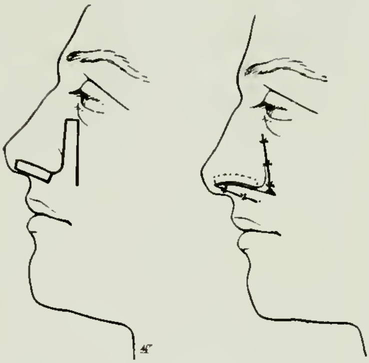


FIG. 198.— To make ala from side of nose with pedicle on check.

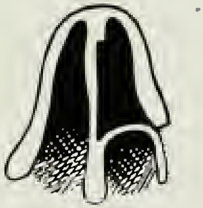


FIG. 199.— Septal flap to line new alae and avert cicatricial occlusion of nostril.

cut vertically and includes a strip of cartilage about the size and shape of the deficiency in the nose. This flap is folded and sewed into the defect so as to have a skin surface on both the outer and inner aspects.

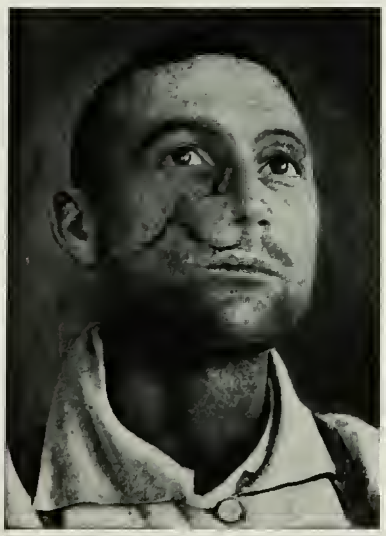


FIG. 200.— Partial rhinoplasty with flap from cheek. (*Keen's Surgery.*)

To construct the columella, cartilage with a pedicle at the back may be obtained from the quadrangular cartilage of the nasal septum and be covered with a labial flap; or instead a free flap containing cartilage may be cut from the ear.

A large and bulbous lobule may be reduced by cutting out a wedge and suturing the wound neatly, or by submucous excision of the superabundant subcutaneous tissue. An elevated lobule is drawn downward by excising a triangular section of the cartilaginous septum.

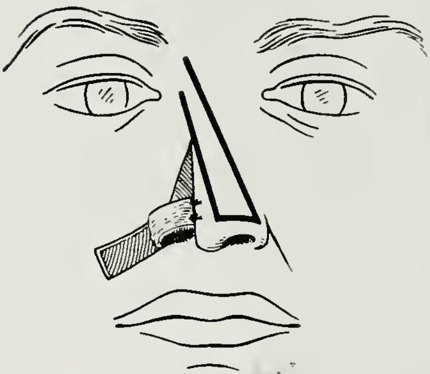


FIG. 201.

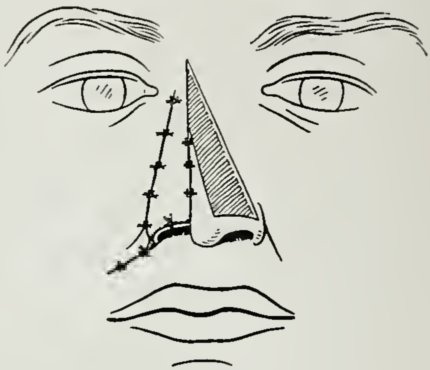


FIG. 202.

FIGS. 201 and 202.—To make the side of the nose and an ala with flaps from dorsum and nose and cheek.

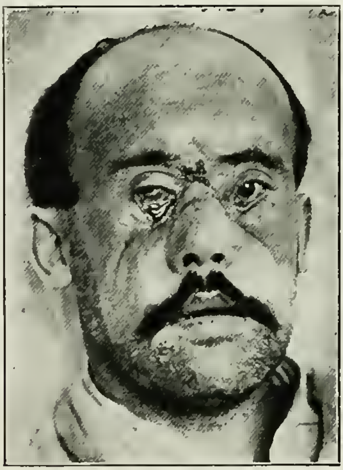
When the lobule is very broad at its base and concave at its sides the excision of an angular diamond shape piece of tissue from the anterior angle of each nostril will correct the deformity. One angle of the diamond or lozenge is near the tip of the nose, the other within the nostril at the front of that opening extending upward on the mucous membrane. The diamond incision is bent, as it were, on the edge of the opening of the nose.

Deformity caused by undue prominence of the nasal tip, or a hook-like appearance of the lower end of the lobule, is relieved by Kolle in a manner somewhat like that of Mikulicz for reducing a large nose.

He cuts away the redundant lower prominence of the lobule and the adjacent parts of the septal cartilage and columella, leaving a flap of the anterior part of the lobule. After removal of

Shell wound causing fracture of maxillae with displacement of bone and large portion of soft parts downwards.
(*Courtesy of Dr. H. W. Scarlett.*)

Immediate replacement with intra-oral maxillary splint supported from cranium was adopted.
(*Courtesy of Dr. H. W. Scarlett.*)



Later appearance of patient. Ectropion of eyelids to be operated upon subsequently.
(*Courtesy of Dr. H. W. Scarlett.*)

Fig. 203.

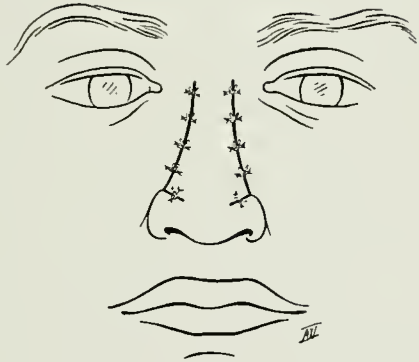


Fig. 204.

Figs. 203 and 204.— To reduce size of nose when soft parts are too bulky. Diagrams show lateral view and front view.

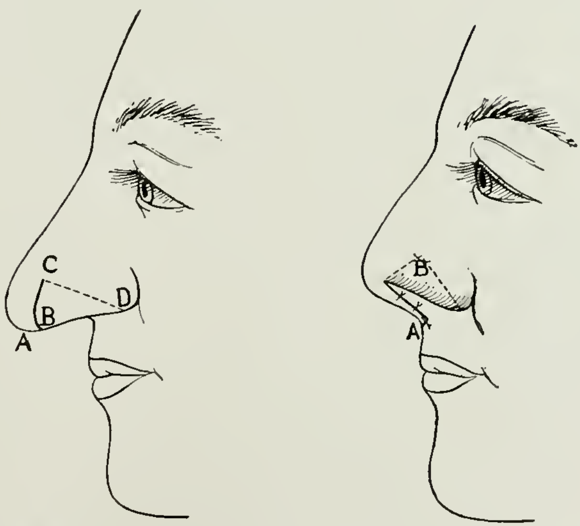


Fig. 205.— Mikulicz's method of reducing lobule and ala by cutting out a triagular piece of the septum C D, folding in the ala from B, and turning back point A.

sufficient portions of the two alae, the flap of lobule is bent backward and sutured to the stump of the columella. Then the raw surfaces at the lower margin of the wings are closed with sutures, either with or without further excision of the contained cartilage.

When the prominence of the lobule is insufficient it may be advanced by the Gensoul method.

A widened base of the nose may be reduced by excision of wedges just within the nostrils. If the wings are too thick, wedges or pegs of tissue may be cut out.

Abnormal or unsightly prominences of the nasal bones or the nasal processes of the maxillae should be removed from within the nose, with saws or drills and forceps, through submucous incisions, or with chisels after exposure through oblique incision of the overlying skin.

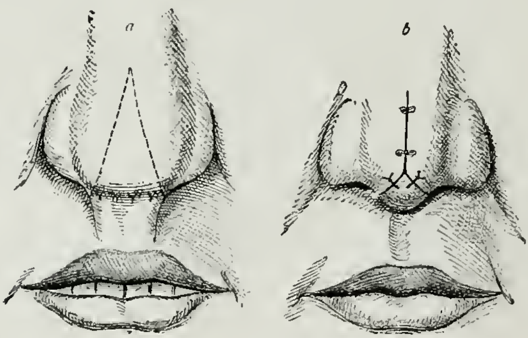


Fig. 206.— To reduce width and bulk of nasal lobule.

PROSTHETIC APPLIANCES FOR NASAL DEFICIENCIES.

Portions of the nose made of wax, copper, vulcanite, or celluloid, properly colored, are at times used.

Great ability has been exhibited by the French in manufacturing, by means of electroplating and artistic coloring, large portions of the face from metal to conceal loss of nose, cheeks, chin and eyes. These " masks " are held in place with springs, spectacles fitted to the ears and pegs entering the nasal cavity. The deception attained by such substituted features is extraordinary. The expense of manufacture is great, but the concealment of unsightly defects of the wounded is often urgently demanded. Copper deposited by electroplating on a plaster-of-Paris model makes an excellent substitute for lost portions of face. It is much used in the present reconstruction of soldiers.

Artificial noses are held in place by means of spectacle frames and by additional support from the floor of the nasal chambers.

FIG. 207.— To reduce size of nose when soft parts too bulky.

Sometimes expanding springs within the nose are used for maintaining the apposition of the false nose to the face. Uncomfortable intranasal pressure must in all these cases be avoided by giving widely distributed pressure; and the prosthetic appliance simulating a nose must be readily removable and so constructed as to show as little as possible the line of junction. When the adjoining portions of the face need to be artificially represented, the nose with the lip or cheek are constructed as one piece. If the palate is perforated, the support may be obtained partly by attachments to the teeth.

Much interesting information on the details of prosthetic reparations will be found in Prothèse restauratrice bucco-faciale by Martinier & Lemerle, and in the reports of the work in England of Captain Derwent Wood of the R. M. S. In Philadelphia, Major R. Tait Mackenzie has made interesting studies of prosthetic repair of war mutilations of the face.

The normal contours and colors of the face may be simulated after war mutilations by prosthetic parts made of thin metal. These are painted or enameled and are then kept in place by attached spectacle frames or springs or by projections thrust into the nasal openings or into cicatrized perforations made in the soft tissues. The procedure is as follows: Make a plaster mould, or impression, of the deformed face; in this mould make a plaster cast of the face; upon the cast, model in sculptor's clay an appropriate nose, ear, chin or cheek; make a plaster mould of the reconstructed features of the patient; into this mould pour melted wax so as to obtain a wax cast of the needed contours of the prosthetic piece; the surface of this cast of part of the face is then covered with a sticky film upon which is smoothly dusted an almost impalpable bronze powder; the bronzed model is then connected with wires and placed in an electro-plated bath. As a result of these manipulations, the exact surfaces of the modeled new features are reproduced in a thin copper shell. The wax is then removed by melting and the conformed sheet of copper remains. This is accurately trimmed to fit the mutilated face of the patient, silver plated, painted, and soldered to the spectacle frame or other steadying device. The prosthetic appliance is then ready to be worn.

CHAPTER XXII.

REPAIR OF DEFORMITIES OF THE EXTERNAL EAR.

Loss of portions of the auricle is a more conspicuous deformity in men than in women, who usually can cover the defective feature by a special arrangement of the long hair. Deformity occurs from scarring and distortions after loss of sections of the auricle by wounds, frost-bite with gangrene and cicatricial adhesions or contractions. Blows, causing subcutaneous hemorrhage and swelling, or fractures of cartilage, result in crumpled and nodose auricles. These are seen in boxers of the present day and are evident in the marble representations of gladiators of ancient nations.

It would be possible to transfer an external ear, by means of a pedicle, from one person to another person. The two patients would be obliged to lie in bed in contact for about two weeks before it would be safe to divide the pedicle from the donor. Perhaps an entire auricle might be transplanted, as a graft, from one man to another, if the careful technic and vessel anastomosis were as perfect as in Carrel's laboratory experiments.

The ear to be transferred should be allowed to receive its circulation through a broad pedicle connecting it with its original owner. The method should be to detach the donated ear from above downward and have the pedicle below where the temporal and posterior auricular arteries would remain unsevered. It would be wise to include in the tissues separated from the donor's skull a quite large extent of skin and fascia around the attachment of the auricle, in order to give a large surface to form vascular adhesions to the tissues of the recipient. I should be inclined to insert the edges of this flap base under the integument of the recipient after freshening the upper surface for about a third of an inch from the margins. After two or three weeks, union would probably be sufficient to allow division of the pedicle.

The other method would be to first attach the ear to the hand of the donor or recipient and after two or three weeks divide the pedicle connecting it with its original site. The hand to which it had grown fast could then be fixed to the side of the head of

the would-be recipient and suitable sutures inserted to secure union of the ear in the proper situation. Two or three weeks later the attachment of the transported ear to the hand should be cut.

An artificial ear, modelled after the normal ear of the patient, may be made of copper or of celluloid, and fastened to the side of the head with a spring bearing upon the internal wall of the external auditory meatus. If the entire auricle is not absent, the parts remaining may be used for the attachment of the mechan-

Fig. 208.— Reconstruction of lower part of auricle with flaps from neck.

ical representation of the missing portion. Small cicatrized orifices may be made in the remnants of the ear, as is done for the wearing of earrings. Through these openings, delicate wires and bolts with nuts may be carried to support the light artificial ear. When the surface of the auricular region contains no hollows or elevations suitable for such connections, a thin aseptic plate or band of silver or other material might be inserted under the skin of the cheek or scalp and allowed to become encysted there. This might have a screw or socket projecting through a cicatrized opening in the integument, to which the artificial ear

may be attached. Prosthetic appliances of this character have been greatly improved in recent times because of the need for prosthesis in extensive war wounds.

Organs repaired by permanent displacement of human tissues are very satisfactory. It requires, however, operative skill on the part of the surgeon and patience and confidence on the part of the subject to insure even a fairly successful construction of an ear or nose or larger section of the face. The results may, however, be very good, if successive operations, during two or three years, are performed with reasonable skill after thoughtful

Fig. 209.— Releasing auricle attached to mastoid region by scar of burn, by using pediculated flap from back of neck.

planning. Considerable time must be permitted to elapse between the operative stages, to give time for subsidence of inflammatory swelling and induration. Several months' interval will often be needed for this purpose.

If the auricle has been only partially destroyed by the wound, much may be done by creating new contours and inserting new structures. The required skin and subcutaneous tissue may readily be transferred from the adjacent cheek and neck, when these surfaces have not been changed into cicatrix by the original injury or prior operations. The newly formed parts may be stiffened with grafts from costal cartilages, chips of bone, or

injections of paraffin. These rigid supports may be inserted at the time of the plastic reconstruction or at a later time. The method of operating suggested by Szymanooski is shown in the illustrations.

My own preference is to cut two flaps with their pedicles downwards, as shown in the figure from an actual operation.

These are made in the aural region through the skin and underlying fascia at the side of the head, avoiding the hairy parts as

Fig. 210.—Flap from neck turned upward to reconstruct lobule of auricle after necrotic burn. Dark space is unhealed granulating area. *(Author's patient.)*

much as possible. They get a good blood supply from the temporal and posterior auricular arteries. Each of the flaps is the shape of a boy's shinny stick. They have their convex borders toward each other. The lower part of these edges should be contact for about one-fourth of their length, and the line of contact should run a little obliquely backward as it extends upward.

The incisions outlining the flaps diverge as they ascend. The two flaps in the upper portion of their extent are separated by a half or three-quarters of an inch. They are raised and placed together, raw surface to raw surface. Through and through sutures placed at needed intervals hold the raw surfaces smoothly in contact, so as to avoid pockets for retention of blood between the flaps.

The through and through sutures may be threads of pure rubber with shot clamped on the ends. These are placed with a large eye needle and prevent injurious pressure by stretching during inflammatory swelling and contracting when it disappears. The two flaps have their edges also united by sutures. This duplex flap, when turned on its concave edge, will resemble a crudely shaped ear. It should have its concave margin beveled and mortised into a crescentic incision in the skin at the position which a normal ear would occupy. Careful suturing with silkworm gut and silk will accomplish this without much difficulty. The wide upper part of the flap should be curved well forward so as to represent the broad upper part of the external ear. Silver wire filigree or shavings of costal cartilage may be subsequently introduced to give a certain degree of rigidity to the aural substitute. Modifications in shape may be made by repeated small operations. The essential is to obtain at first a bulky mass resembling in general outline the other ear. Subsequent shrinkage will be great, and growth may not keep pace with the development of other parts of the face. Hence the new structure must be made large.

When no external auditory meatus is seen, the surgeon may search for it by dissecting up the soft parts in the region, where the opening is expected to be found on the bone. If the meatus is indicated by a dimple or sinus in the skin, the bone under that point should be the seat of exploration. A racquet-shape flap raised over the suspected opening in the bone is probably as good an exposure as any. If the bony canal is found, it may be enlarged carefully, if necessary, and its wall smoothed with a burr or other instrument driven with the hand or a surgical engine. Its interior may be lined with the flap of skin made by the exploratory incision. A tubular canal should be made from this flap with a pedicle and used to give a cutaneous lining to the

auditory canal. It is difficult to construct a meatus which will not become closed by cicatricial changes. Mucous membrane grafts from the lower lips or prepuce might be used to line the new canal. It might be possible to attach a metal substitute for the entire auricle to the inner wall of such a bony canal by flanges or wires carried under the skin. These would remain in cicatricial canals or perforations.

The external ear is quite often the seat of incised and lacerated

Fig. 211.— Constructing upper part of external ear with flap from cranium. Method is useful in frost-bite, sloughing of helix.

wounds, which require accurate suturing to reproduce the normal outline. Portions of the organ are lost not infrequently in drunken brawls by biting. The auricle may be torn almost completely from the skull, and yet be easily restored to its normal appearance by a few carefully placed stitches. Aseptic cleanliness and accurate coaptation will yield unexpectedly good results. Completely detached pieces should be cleansed and sutured in position, even when some time has elapsed since the receipt of the injury. Occasional union may be obtained even in such cases, by keeping the replaced fragment warm and sterile. The ears of prize fighters often receive injuries which result in permanent cicatricial deformity. Sexton called attention to the

fact that the statues of the ancient Greeks show a familiarity with the characteristic distortion of the boxer's ears.

Sloughing after frost-bite or burn is a not unusual cause of auricular disfigurement. Plastic restorations will greatly improve the appearance of many such ears. A lobule may be made from two crescentic flaps cut from the cheek near the ear, properly stitched together. A fair helix may be constructed from a crescentic flap cut from the skin above the ear and folded longitudinally. Ingenuity in these operations is capable of giving much satisfaction to the patient, who is disconcerted by the

FIG. 212.— External ear being repaired by post-auricle flap. Further modeling of transferred mass is required.

uncomely outline of his ear. Great losses of tissue may demand that free flaps or flaps from the thigh or abdomen, transported by means of the hand as a carrier, be used for restoring the organ. Pedunculated flaps may be turned up from the shoulder or neck. They may be tacked to the side of the skull with ordinary carpet tacks or small staples, when there is no good integument to which to fasten them with sutures.

Wounds in military encounters show every variety of laceration, incision and contusion including removal of entire external ear. The general principles of treatment are those which have been discussed in the management of injuries of the other portions of the face. Early asepsis and replacement with maintenance of correct

apposition, except when an impending or present infection necessitates free drainage for a few days, are essential for good results Foreign bodies must be removed. This may require the aid of a head mirror when small particles of stone or of missile have been projected into the auditory canal.

An effusion of blood beneath the perichondrium may occur from injury to the ear and cause marked chronic deformity. This condition, called othematoma, has been considered of frequent occurrence among those mentally unsound. It is possible that the condition is at times non-traumatic; but, on the other hand, a slight injury causing it may readily have been forgotten. The

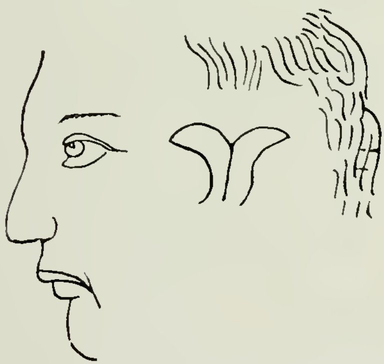


FIG. 213.— The author's incisions for making an auricle in loss of the entire pinna.

FIG. 214.— Patient showing prominence of upper portion of auricle obtained by author's method in congenital absence of whole ear except lobule.

usual site of deformity from such a swelling is on the front of the auricle, because of the less absorptive power here and the adherence of the tissues to the cartilages. The tumefaction may disappear by absorption, may rupture with discharge of its contents, or may be followed by suppuration. Occasionally necrosis of the cartilage, with secondary distortion from atrophy, hypertrophy or disfiguring contraction, happens. Aseptic incision to evacuate the imprisoned blood before the condition becomes chronic would seem to be the proper surgical treatment, though this method of treatment has been deprecated by some and preference given to massage.

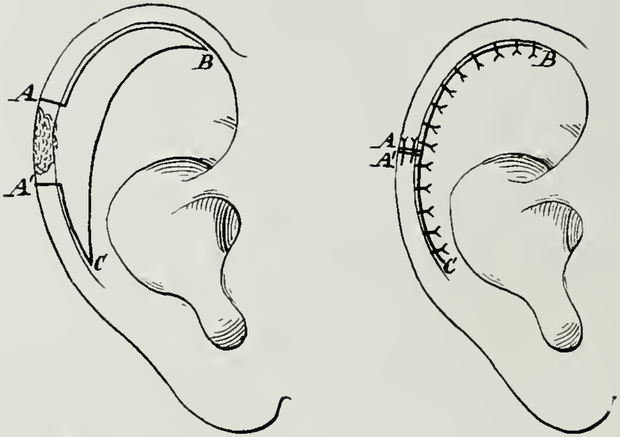


FIG. 215.—Method of repairing auricle when necessary to excise a lacerated portion or to repair a wound.

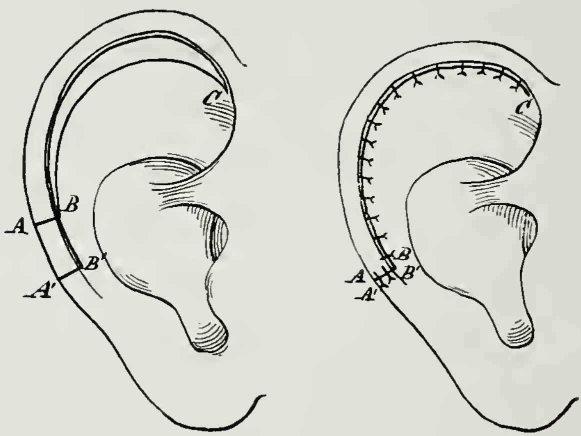


FIG. 216.—Gersuny's method when part is lower down in helix.

The form of the pinna, or external ear, made by the surgeon after the suturing and healing of the cartilages and other wounded tissues may need modification. It is well to be satisfied after plastic recreation of a pinna, which has suffered loss of tissue, with a crude representation of its proper conformation. Later minor operations may greatly perfect its contour or add

rigidity to soft and flaccid structures. The result to be held in mind is that the reconstructed ear is to match so far as possible the uninjured one in shape, size, position on the side of the head and rigidity. It may be easier to reduce the unwounded ear so as to match that which has been made out of the remnants of the one damaged by gunshot trauma.

Outstanding or flaring ears may be held back against the cranium by making more acute the angle between the auricle and the skull by a simple operation. The angle between the cranium and the back of the auricle must be reduced so that the pinna is held permanently closer to the head. This is done by cutting away the skin and superficial fascia in the groove between the head and the ear and stitching the organ in its new position. The wound, so made, consists of a raw surface, which is a semi-ellipse on the cranium and a similar semi-ellipse on the back of the ear. The two halves of the elliptical denudation are often not symmetrical, nor is the ellipse always true. It is necessary to vary the outline of the denuded area to insure a proper reposition of the auricle. The shape of the crude ear may require that the ellipse be wider at its upper than at its lower portion. Usually the semi-ellipse on the ear should be broader, I think, than that cut on the cranium. The upper end of the elliptical wound should curve around the top of the concha. Where the pinna needs to be drawn closest to the head the width of the excised part of the skin should be greatest. A quite large area of skin and fascia should be removed and some of the auricular cartilages should be cut out. Unless a narrow strip of cartilage is removed in the line of the proposed bending, its resiliency will probably make the operation inefficient, and the deformity will recur. Perforation of the skin on the front of the ear should be avoided. This is generally quite possible, although the integument in front is more adherent to the cartilage than is that on the back of the organ.

Exceedingly large ears may require operation because of their unsightliness. If they are not flaring, or if the operation for flaring ears is not capable of reducing their apparent bulk sufficiently, the bulk of the ear should be lessened by excision of cartilage and integument. A V-shaped portion of the entire thickness of the auricle, with its base at the external margin of

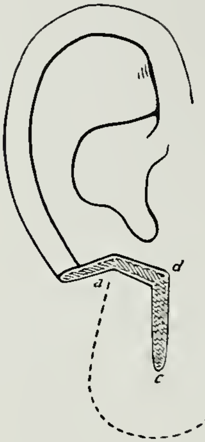


FIG. 217.

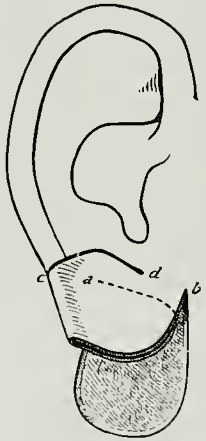


FIG. 218.

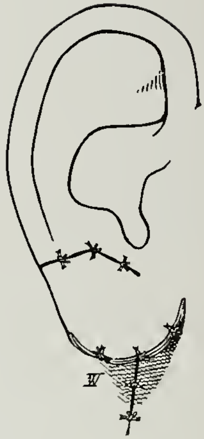


FIG. 219.

FIGS. 217, 218 and 219.— Method of constructing a lobule after its excision or avulsion with sword or by gunshot wound.

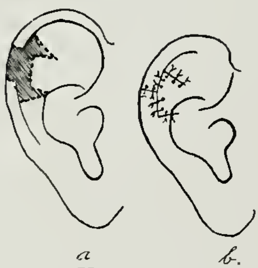


FIG. 220.— Kolle's method of reducing cars. Useful method when companion is too small.

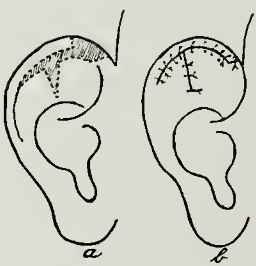


FIG. 221.— Kolle's method to put the scar in helix nearer the hair.

the helix, should be cut out. Careful suturing will restore the general outline and maintain the regularity of the natural elevations and depressions. The operation of Parkhill probably permits a more perfect restoration of the surface of the auricle. By it a crescentic piece is cut out of the center of the pinna with a tongue-like process extending from the convex border of the crescent to the edge of the helix.

Instead of excising a tongue with parallel margins from the outer part of the auricle, a wedge of cartilage and skin may be removed. This modification permits a more extensive diminution of the circumferential part of the pinna than the suggestion of Parkhill. The position and size of the crescent and the wedge to be cut from the gigantic ear must be determined with care. They must vary with the situation of the over-growth of the auricular structures.

When portions of the helix and adjacent tissues of a normal ear have been lost by wounds or gangrene or removed in excising tumors, the organ may be constructed by using incisions similar to those just figured. The result will be a smaller though shapely ear. The opposite ear may then be cut down in size by the same methods, to match the reconstructed one.

CHAPTER XXIII.

REPAIR OF TRAUMATIC DEFORMITIES OF EYELIDS AND GLOBE.

Wounds of the eye in connection with other facial traumatisms of war are of grave import. The surgeon, if not alert to this fact, may have his attention so fixed on extensive lacerations of cheeks, nose or mouth as to overlook impending blindness from an insignificant puncture of the eyelids or eyeball or the existence of cerebral injury with few symptoms except those exhibited by the eye.

Careful examination of the eye is therefore demanded in penetrating gunshot wounds of the head, contusions liable to cause fracture of cranial or facial bones and widespread lacerations of soft structures of the face as well as in wounds in the vicinity of the eyes themselves.

The military surgeon is not expected to be an expert ophthalmologist, but he should have a general knowledge of the surgery of the exterior of the eye and its appendages and the needful first aid therapeutics of eye lesions complicating general surgical lesions of the face. A working familiarity with oblique illumination for detecting foreign bodies impacted in the cornea and for recognizing lesions within the anterior chamber will be of much assistance to him. If he has learned to use the ophthalmoscope, his ability as a diagnostician will be greatly enhanced.

Much plastic work is required of the operator, who undertakes to reconstruct injured and distorted faces. Facial disfigurement received in war, whether due to projectiles, burns, swords, or bayonets, is very apt to involve the eyelids. Their function being to protect the cornea requires that they be ample in size, non-adherent to the globe, not everted or inverted, and capable of conducting the tears into the lachrymal duct.

Removal of foreign particles from the conjunctival sac or from the surface of the cornea should be promptly done after their presence is discovered by the surgeon. The instillation of a few drops of a 1 or 2 per cent. solution of cocaine hydrochloride will cause local anaesthesia in about five minutes. The surgeon

standing behind the patient should have him look downward with his head steadied against the back of a low chair. The operator then seizes the lashes of the upper lid with a thumb and finger, draws the lid downwards, and away from the curved surface of the eyeball, and suddenly everts it over a narrow stick or probe, placed with his other hand horizontally across the skin surface of the lid above the upper border of the so-called tarsal cartilage. This eversion exposes the mucous lining of the upper lid, upon which minute particles of dust are apt to be found, if freely movable in the space between the lids and the globe of the eye. A wisp of sterile cotton may then be used to wipe away the foreign body.

If the suspected particle, blown into the conjunctival sac by the wind, is not seen when the lid has been everted, the lower lid and especially the front of the cornea should be carefully examined. This is best done by throwing a cone of light upon the globe, with a double convex lens of short focus, from the sun, an electric light or a gas flame situated at the temporal side of the eye. Specks seen upon the glistening cornea should be wiped away with a sterile wisp of cotton twisted around the end of a match stick or a probe. If the foreign body has been pressed into the cornea or conjunctiva, perhaps by the patient having rubbed the eye with his fingers, a sterile spud or needle may be used to lift it out of the epithelial layer of the cornea. After these little operations it may be well to wash out the conjunctival sac with a weak boric acid solution (gr. v to the ℥j) or a sterile salt solution. Particles of unburnt black powder may be driven into the cornea or conjunctiva. They should be assiduously picked out, lest they cause blue tattoo marks.

More serious injuries to the eyeball require special ophthalmic treatment. The non-specialist should remember, however, that the eyelids swell very greatly when the seat of extravasated blood or inflammatory fluids. This makes it difficult to see the cornea because of the difficulty of drawing the lids apart with the examiner's fingers. The orbicular muscle resists the attempt.

It is important, moreover, that the condition of the cornea be known, because wounds or beginning inflammation (keratitis) may be concealed by the swollen lids. The instillation of a little 1 or 2 per cent. cocaine solution may relieve pain and permit the

separation of the lids with the surgeon's fingers. If this fails, he should elevate the upper lid with a small eyelid retractor and draw down the lower lid with the fingers of the other hand. A glance will usually be sufficient to let him see whether the cornea has its normal bright glistening appearance without spots of cloudiness or ulceration, whether behind the cornea there is blood, or pus in the anterior chamber, and whether the globe of the eye in any anterior region has been torn or cut with small missiles or fragments of metal. To insure this general integrity of the eyeball, it may be wise to give the patient the benefit of a moment's general anaesthesia, such as is readily secured by the primary anaesthetic action of a few concentrated whiffs of ether, or a few breaths of nitrous oxide gas.

Penetrating wounds and even contusions of the globe, whether of cornea, iris, or deeper structures accompanying wounds, are very liable to be followed by iritis. This, if neglected, leads to adhesion between iris and lens with consequent defective vision or total blindness. Panophthalmitis may occur from infectious processes so induced. Hence all doubtful cases of intraocular trauma in the hands of men inexperienced in ophthalmology should be treated with a prompt institution of three or four drops of a 0.5 or 1 per cent. solution of atropin sulphate. This mydriatic will dilate the pupil by its action on the iris and quiet the eye. Exclusion of light and the occasional repetition twice or thrice daily of the atropin instillation will often be a reasonable safeguard until ophthalmic skill is obtainable. Such a strong mydriatic should seldom be omitted in traumatism of the eye.

It is not wise to tie eyes up with bundling dressings, which hold the lids together and prevent drainage from the conjunctival sac. A simple splinting of the upper lid by means of three or four superimposed semiellipses of adhesive plaster placed on the skin of this lid just below the upper border of the orbit will prevent the eye being opened by the voluntary efforts of its elevator muscle. Tears and other secretions will then drain out over the lower lid, and atropin, boric acid or other solutions may be instilled frequently by dropping the liquid between the edges of the lids while the patient lies on his back or throws his head backward while sitting up.

The surgeon should recollect also that small wounds at the corneo-scleral junction are very dangerous. They are apt to cause increased intraocular tension leading to hardening of the eyeball and glaucomatous blindness. He should know by palpation through the upper lid the feeling of soft fluctuation of the normally tense globe. Any increased hardness should arouse suspicion and lead to a resort to special ophthalmic skill.

Foreign bodies like pieces of metal allowed to remain *within* the globe, though small and apparently doing no harm, usually lead later to sympathetic ophthalmitis of the other eye. As a result the patient may become blind in both eyes, from delayed inflammation of the internal structures of the one originally hurt, and sympathetic involvement of the other. If the foreign body cannot be removed by exploration and extraction with magnet or forceps, it is frequently wise to enucleate the wounded eyeball rather than run the risk of sympathetic inflammation of the other. Deficient promptness in recognizing the danger of incarcerated foreign bodies has caused the total blindness of many eyes.

Incised lids should be carefully sutured in a manner to get accurate coaptation of the edge. Any tension of sutures below the eye in closing wounds of the cheek, likely to draw down the lower eyelid, should be avoided. This may be accomplished in some wounds by making undercuts to allow sliding of the skin and superficial fascia, thus changing the place of tension to a point away from the eye.

The normal position of the canaliculi through which the tears reach the lachrymal sac should not be disturbed unless absolutely necessary to do so. The inner angle of the lids should lie close to the globe in order to suck up the tears. The normal direction of the outer canthus should not be shifted by the suturing necessary to close wounds; nor should the eyebrows be displaced or distorted. The palpebral openings should be allowed to remain as symmetrical as possible.

Many soldiers receive transverse wounds of the head through both eyeballs. Cutting off the optic nerve may cause instant total blindness in one or both eyes. Fragments of bone from the walls of the orbit or from the crushing of the fragile ethmoid bone may be carried as multitudinous projectiles into the second eye. Complete rupture of the globe may, therefore, necessitate

enucleation of the eyeball at the time of immediate treatment. If the capsule of the lens is torn, never so little, by penetrating or contused injury, a gradual opacity may occur from absorption of fluids and a traumatic soft cataract be developed. Dislocation of the lens may occur, causing it to be thrust into the anterior chamber, where it becomes readily recognized. Swelling of the lens, if rapid and great, may be accompanied by traumatic glaucoma.

It is proper to call attention to these more obvious results of war injury, but in most of such cases ophthalmic surgeons alone have the requisite experience to afford the operative skill demanded for the salvation of sight.

The removal of intraocular foreign bodies has been greatly aided by the use of x-rays. Skilled roentgenologists can determine with a very great degree of accuracy the situation of the piece of lead, steel, copper, or bone which has been projected into the interior of the eyeball. This renders extraction feasible in many instances with the preservation of useful vision.

The alterations in size and reaction to light of pupils, and the occurrence of strabismus in cerebral injury and the early or late appearance of subconjunctival hemorrhage are often valuable guides to localization of the exact seat of bullets and other metal objects imbedded in the brain. The careful study of varying x-ray plates, taken with scientific accuracy and checked up with clinical symptoms, will often aid the surgeon in determining the nature, situation and probable outcome of exploratory incision.

The use of the flat burr driven by the surgical or dental engine, suggested by me many years ago for perforating the skull, has been developed by various modifications and improvements in recent years to an unexpected extent. The present methods of making exploratory openings in the cranium are almost without danger. To remove projectiles from the orbit is a troublesome operation, but by a strategic resection of the outer wall, as suggested by Krönlein for removing post-ocular tumors, the surgeon has an excellent exposure of the parts. The outer canthus can be split and the eyelids turned away from the eyeball so as to give greater room to explore the upper and lower walls of the eye-socket. The superciliary margin may be temporarily dis-

placed, as may the lower or maxillary border, if a bullet or small piece of shell case or shrapnel is deeply buried.

Pyogenic infections may spread from wounds near the eye, and give rise to suppuration in the tissues of the eyelids, in the lachrymal sac and even involve the lachrymal gland which lies above the eyeball under the temporal end of the orbital roof. In any or all of these may develop localized abscess. There will be great swelling of the involved structures and difficulty of locating the exact focus of the purulent inflammation. The surgeon must obtain a view of the cornea and see that it is not involved. With this caution, the treatment is that well recognized in general surgery. The conjunctival sac should be kept as clean as possible by frequent irrigations of sterile salt solution or boric acid solution introduced between the eyelids. Other mild antiseptic solutions may be used, but those mentioned are sure to do no harm. Small pads of gauze moistened with warm water and covered with waxed paper or rubber tissue, placed over the closed lids, will hasten maturation of the abscess. Free incision should be made as soon as the focus is indicated by fluctuation or any initial evidence of pointing.

The very destructive suppurative infection of the conjunctiva due to the gonococcus must be always in mind in military camps. The patient with gonorrhoea frequently inoculates the eye with this bacterium. It causes a violent purulent conjunctivitis, accompanied by intense swelling of the lids and profuse discharge of pus. It quickly destroys the cornea by ulceration and sloughing. Strong applications of silver nitrate to the mucosa of the lids, applied with protection of the cornea from contact with the caustic applicator, has saved some eyes from blindness. It must be used early, skillfully and the excess neutralized with sodium chloride solution. The application should be repeated. Gonorrhoeal conjunctivitis is too serious an affection to be treated successfully by one not an experienced oculist. The condition is mentioned here because of the danger of mistaking it for a less destructive purulent infection of the conjunctival sac due to the common pyogenic microorganisms. The sound eye is very liable to become attacked because of the profuseness of the discharge and the ready transfer of pus from the diseased eye by the fingers

of the patient. The well eye should be covered with a protective eye shield of some sort.

It occasionally happens that after operations on the cheek below the eye subcutaneous hemorrhage may cause eversion of the lower lid by increasing its bulk. This condition may last several weeks, if the clot be aseptic and become organized and hard. The result is that the everted lid carries the lower lachrymal canaliculus away from its normal position of contact with the eyeball. An overflow of tears therefore occurs which

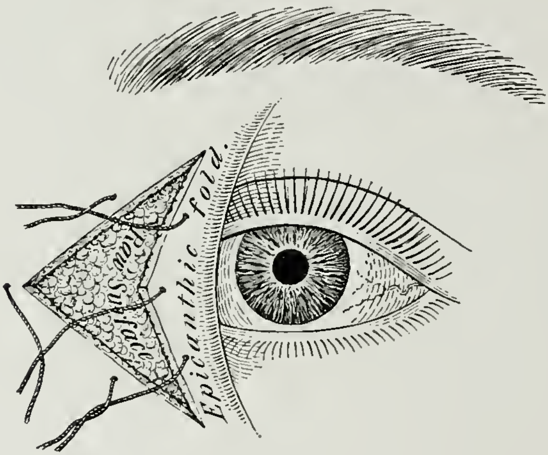


Fig. 222.— Arrow head excision to cure deformity of epicanthus.

may be very annoying. Light massage and time will slowly cure this condition as the blood is absorbed. If it become septic the pus should be evacuated by an incision. During this period a mild antiseptic wash may be occasionally dropped on the conjunctiva to prevent irritation of the eye and cornea from exposure to dust. Such a collyrium will have some influence in keeping the lachrymal sac from a possible infection through the tears which gain access to it.

Cicatricial contraction, after wounds or sloughing of the nasal region, may cause the skin of the forehead to be drawn down so as to create a traumatic epicanthus. This will require plastic operative treatment similar to that employed for the correction of congenital epicanthus.

There occur instances of acquired ptosis of the upper eyelid. This is due to palsy of the elevator muscle from wounding of the motor nerve to that muscle, lesion of its cerebral center, or to laceration of the muscle itself. The drooping eyelid will require perhaps a plastic transfer of fibers from the frontalis muscle.

Palsy of the motor supply to the orbicular muscle for closing the eyelids may occur from gunshot or other wound of the facial nerve, behind or in front of its exit from the stylomastoid foramen. Muscle transfer here also may be a solution of the difficulty; or spinal accessory nerve anastomosis with the terminal section of the palsied facial nerve may be available.

Traumatic epicanthus is an abnormal fold of skin overlying the internal canthus of the eyelids similar to that which is seen in congenital cases of epicanthus occurring with flattened and broadened nose. The traumatic, as the congenital, form may be bilateral or unilateral.

A section of skin the shape of an arrowhead, with the point toward the nose, may be excised from each of the voluminous folds concealing the inner angles of the eyelids. The application of sutures draws the superabundant integument away from the eye and the deformity is permanently relieved. This operation is indicated in those cases of epicanthus which are too marked to be relieved by the excision of a vertical ellipse of skin from over the bridge of the nose.

A rare congenital condition is the presence of a fold of skin extending from the brow to the malar region, so as to cover the external angle of the eyelids. To it the term external epicanthus has been applied. It should be treated by a plastic operation similar to that just described. A similar cicatricial band is possible should a sloughing wound cause dragging of the integument in the temporal region.

Bilateral internal epicanthus may give the impression to an inexperienced observer that internal strabismus exists. The deviation of the eyeballs is, however, only apparent, as will be quickly recognized by careful inspection.

Traumatic ptosis may result in the eye being entirely closed, or there may be only an inability to lift the upper lid sufficiently to completely uncover the cornea. Drooping of the lid from injury, inflammatory causes, scar contraction, or weight due to

tumors, occurs in cerebral or peripheral disease involving the whole of the third cranial nerve or the branch supplying the elevator of the upper lid. In such instances the immobility of the upper lid and the covering of the cornea is more likely to be complete than in congenital ptosis. Many instances are syphilitic. The bilateral drooping of the upper eyelids often seen in hysteria must not be mistaken for ptosis requiring operative treatment.

If it is found that medicinal treatment, even when combined with the local use of electricity, has not been effectual in relieving

Fig. 223.— Roberts's muscle substitution operation for congenital ptosis on left eye. This improvement continued as was shown when patient was examined two years afterward by operator. See Fig. 225 on page 393.

ptosis, operative attack is proper. The natural elasticity of the skin of the lid and the deficient power of the elevator muscles in many cases make the permanency of the surgical improvement often disappointing. Many operations have been employed to give the patient control of the lid. The impossibility of opening the eye completely is not only a disfigurement, but may interfere with the vision of the eye or eyes from the pupil being covered continually.

The removal of a transverse ellipse of skin, with the subcutaneous connective tissue, from the drooping lid, would seem to be indicated. This procedure is of little permanent service, how-

ever, even if some of the fibers of the orbicular muscle be excised with the skin and subcutaneous structures, unless the amount of the ptosis is very slight. Fair success in moderate degrees of ptosis may be obtained by removing not a narrow ellipse of skin and subcutaneous fascia, but a wide section of these structures, which has a convex upper border near the bony margin of the orbit and an almost horizontal border from right to left along the free edge of the lid close to its lashes. Some fibers of the orbicular muscle and a narrow elliptical strip of the tarsal cartilage itself should be cut out. The area of tissue to be cut away from the drooping lid is the difference between its length and that of the normal lid.

The occipito-frontal muscle must be utilized to lift the drooping upper lid in those cases in which the elevator of that structure is absent or paralyzed. This may be done with fair result in minor cases by causing the formation of cicatricial bands of fibrous tissue beneath the skin of the lid. These will connect the lower portion of the lid with fibers of the frontal portion of the occipito-frontal muscle. This object may be accomplished by carrying two or three subcutaneous mattress sutures from the region just above the lashes to a point above the eyebrow. Each thread is introduced from below upward by means of a straight needle on each end. The suture is tied over a little piece of fine rubber tubing, after the falling lid has been drawn up sufficiently to correct the deformity. The sutures may be untied and tied a little more tightly every few days, until they cut their way through the subcutaneous tunnels, leaving scar tissue in their tracks.

A more direct attachment of the frontal muscular fibers to the upper lid may be obtained by raising a vertical tongue of skin from the surface of the lid at its center, which is carried through a subcutaneous tunnel under the eyebrow. It is stitched to the frontal muscular belly after sufficient skin and fascia have been dissected from the skin of the lid to make the depth of the affected lid correspond to a normal upper eyelid. All of the wounds are then neatly united by sutures. The tongue should have the part of its skin surface which is to be buried denuded of the epithelium.

Instead of using this tongue of skin to make the connection, it would seemingly be easy to dissect through an incision on the forehead a band of muscle, and carry it through a tunnel to be stitched to the tarsal cartilage, in a manner similar to the method of transplanting tendons of the hand and foot.

A more elaborate operation than those described utilizes a small strip of tendon taken from the superior rectus muscle of the eyeball. This is cut from the middle of that tendon, after incising the conjunctiva. It is carried up through the under surface of the everted upper lid and its elevator tendon, near the upper margin of the tarsal cartilage, by means of a mattress

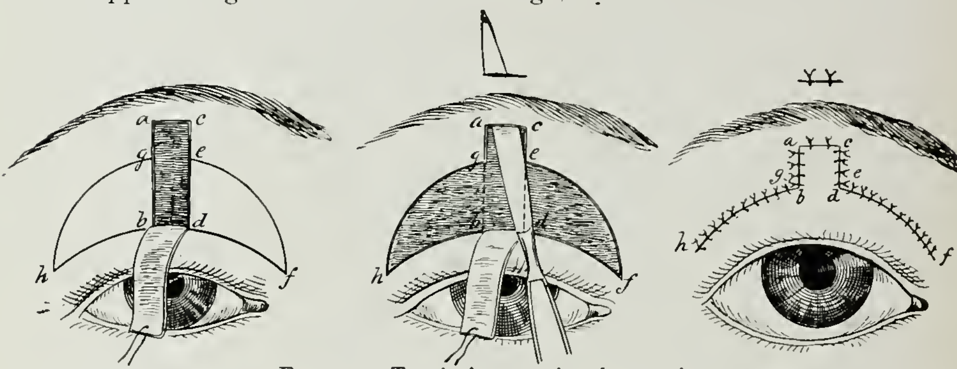


FIG. 224.— Tansley's operation for ptosis.

suture with a small needle on each end. The end of the tendon to be transplanted is then drawn into a pocket prepared for it and is attached to the tarsal cartilage near the insertion of the tendon of the weak elevator of the lid. Finally the two ends of the suture are brought through the skin of the upper lid at points slightly separated from each other and are tied. This operation requires considerable operative skill and leaves for a time double vision, due to the post-operative weakness of the muscle which rolls the eyeball upward.

Perhaps a better method in the severe cases of ptosis is that which shortens the suspensory ligament of the lid by means of two buried mattress sutures. By these stitches the tarso-orbital fascia and the tendon of the elevator muscle are shortened by making horizontal gathers. These structures are uncovered by a horizontal cut about two inches long upon the upper orbital ridge just within the eyebrow. The skin and orbicular muscle

are raised to expose the tarsal cartilage and its suspensory fascia. Two silk or chromicized catgut mattress sutures are then introduced through the cartilage near its upper edge, are carried upward through the suspensory ligament, or fascia, and the tendon of the elevator muscle, and are then tightened and tied. The skin wound is closed over the knots after the stitches have shown that the suspensory ligament and aponeurosis of the weak elevator muscle have been shortened enough.

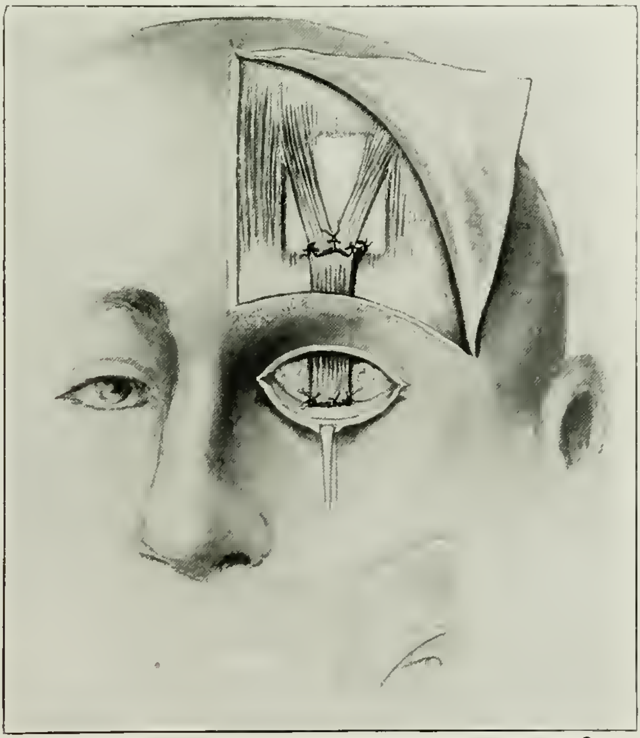


FIG. 225.—Diagram of Roberts's muscle substitution operation for ptosis of upper eyelid.

CHANGING THE SIZE OF THE PALPEBRAL OPENING.

Because of malformations of the lid, paralysis of the orbicular muscle, or protrusion of the eyeball, it may be necessary to make a smaller palpebral opening. This should not be done for cosmetic reasons unless the palsy, the exophthalmic goiter, or other

general cause, has been cured, or at least relieved as much as is likely to be possible, by medical treatment.

Suture of the external canthus is a simple procedure and greatly relieves the staring look often remaining after attacks of exophthalmic goiter. It is not available when the exophthalmos is due to abscess or orbital tumors. Then extirpation or evacuation with drainage is the operation through which to seek cure. Tarsorrhaphy, or suture of the external canthus, narrows the opening of the eye and is done in two ways. The first step cuts away with knife or scissors the muco-cutaneous margin of each lid, with the hair follicles of the lashes, for from three to five millimeters from the external angle of the eye. Sutures then are used to unite these denuded borders. To prevent the union failing at the internal end of the suture line, it is well to denude the inner edge of the lids, without removing the lashes, for a short distance beyond the extremity of the excised flaps.

In a second method the lower lid is split at the external canthus by an intermarginal incision, and then an incision at right angle to the inner end of the first cut creates a skin flap. The corresponding part of the upper lid is denuded of mucosa, skin and lashes. A mattress suture is then used to draw the flap attached to the lower eyelid over the raw area on the upper lid, and the palpebral opening is thus made smaller.

If the opening of the lids is too small it may be enlarged by a canthoplasty. In this operation the junction of the lids at the outer angle of the eye is divided by scissors or knife to the requisite extent in a horizontal direction. The cut includes the conjunctiva, muscle and skin. The lids are separated by tension of the fingers of an assistant or by an eye speculum and the margins of the conjunctiva and skin are stitched together in the vertical direction. This operation may be of value in making the eye look larger when the condition called enophthalmos is present, as from fracture of the orbital bones causing the orbit to be deepened or depressed and thus allowing the eye to drop backward.

Cicatricial narrowing of the ocular aperture will occur after loss of tissue or contraction at the external angle; or that opening may need to be enlarged after such scar contraction has already occurred from burns or other traumatisms. Plastic reconstruction of the angle will be required to restore the palpe-

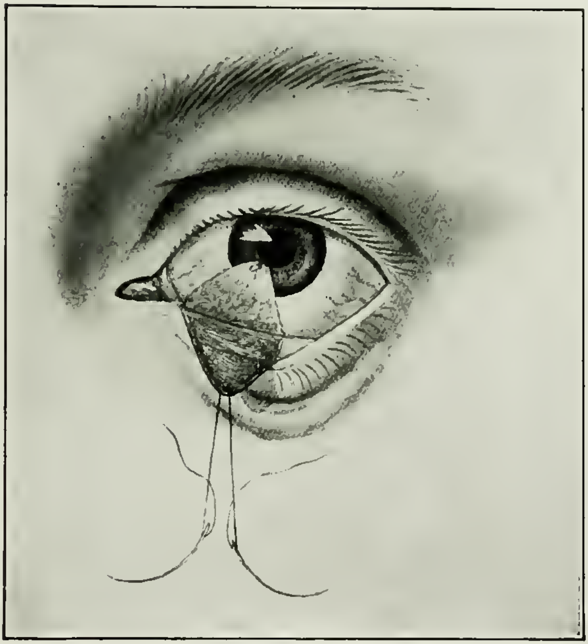


FIG. 226.— Arlt symblepharon operation. The drawing shows the adhesion dissected.

bral opening. This may be done by cutting a forked or split temporal flap with its pedicle below and rotating it through an arc of 90°. Its points should be sutured to the upper and lower lids after excising the tumor or cutting away the scar tissue.

ADHESIONS OF LIDS.

Adhesion of the margins of the eyelids to each other may occur along their entire length or in any portion of their extent. This acquired variety of ankyloblepharon is usually the result of burns from acids, alkaline caustics, or heat, though it may occur from inflammatory destruction or ulceration of the normal surface of the margins of the eyelids.

An allied condition of similar origin and treatment is adhesion of one or both lids to the ocular conjunctiva or the surface of the cornea. This is called symblepharon. Ankyloblepharon and symblepharon may co-exist in the same eye.

When the two lids are connected by bands at their borders, incision to divide the intervening tissue may be all that is necessary. If they are fused together by wide adhesion of previously ulcerated surfaces, the result of extensive injury or disease, the surgeon may be obliged, after cutting them apart, to cover the raw margins with pedunculated flaps of conjunctiva turned up or down from the surface of the eyeball. Thin skin pediculated flaps transferred from the temple, grafts from the post-auricular integument or mucous grafts from the inner surface of the lower

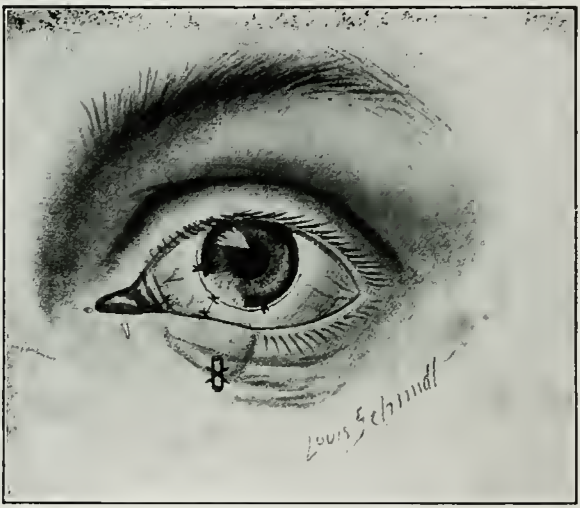


FIG. 227.—Arlt symblepharon operation completed.

lip may be employed. Such operations are in effect cases of restoration of part of a lid. The restoration is usually defective in providing eyelashes.

In adhesion of a lid to the eyeball, similar flap or graft operations are usually demanded. Sometimes the symblepharon is so limited that the raw area left after separation of the lid from the globe may be covered by simply drawing the conjunctiva over it with sutures, after a little undercutting to make it movable. In other instances pedunculated mucous flaps of conjunctiva are displaced by sliding, folding and torsion in the manner which is employed in using skin flaps in plastic procedures to cover cuta-

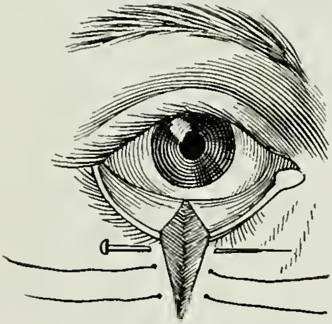


Fig. 228.—Adams ectropion operation.

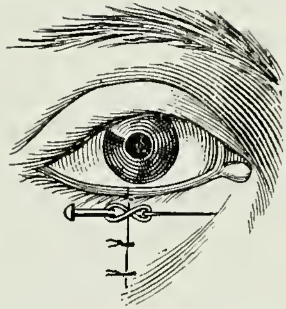


Fig. 229.—Adams ectropion operation, sutures tied. The pin suture is not used now.

neous wounds. Sometimes the adherent portion of lid may be dissected from the eye and be turned by a mattress suture into the groove between the base of the eyelid and the ball. If it is stitched in this inverted position, it will present its cutaneous surface toward the ball, where the latter is left uncovered by conjunctiva or epithelium. The latter area is covered with conjunctival flaps or grafts. Repetition of adhesion is thus made unlikely.

Harlan's method for complete symblepharon of the lower lid is worthy of description. After the adhesion to the globe has been completely divided so that the lid and the eyeball have no restriction in mobility, the lid is detached from the orbital margin by a horizontal buttonhole incision through the skin. This cut makes a bridge of the lid, fastened to the adjacent structures at

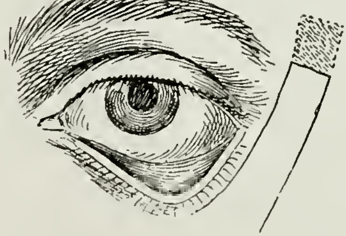


Fig. 230.—Strap flap from temple to lift up lower lid. The skin within the dotted line is cut away to make a raw surface and the strap-like flap is then sutured over the raw space.

its ends only. Through this buttonhole a short but wide flap of skin, cut from the front of the face, is turned up and stitched to the raw inner surface of the lower lid. This procedure lines the eyelid with skin, which has its epidermis toward the wound left on the globe of the eye by the antecedent detachment of the lower lid. The wound of the face is closed more or less completely by sliding skin from the cheek, and the raw surface on the eyeball may be covered with conjunctival flaps or grafts, or with Thiersch skin grafts cut from the thigh or arm. Care must be taken to have a good blood supply for the everted flap which is thrust through the buttonhole. Hence it is well to have some

Fig. 231.—V-flap for oblique ectropion.

muscular tissue in the flap where its hinge is made and to have a sufficient space between the incision which cuts the flap and the incision going through the substance of the lid.

The raw surfaces left after dividing a symblepharon may be covered with Thiersch skin grafts, or mucous membrane grafts. These should be stitched to the conjunctiva of the globe and to the margin of the lid. They may be held more accurately in place by inserting a glass or metal shell over the eyeball. This will press the graft down into the oculo-palpebral groove and maintain apposition of the applied raw surfaces. A semilunar lead disk cut to fit the groove and having holes by which it may be stitched to the margin of the lid and to the graft is a satisfactory device. The skin or mucous graft and disk should be adjusted by sutures to the edge of the eyelid. Then the two lids

Shell wound of cheek and lower eyelid.
(*Dr. Hunter W. Scarlett.*)

Same patient showing torn lower eyelid. This was promptly replaced with deep stay sutures by Dr. Scarlett.

Showing great improvement of eyelid obtained by immediate replacement with sutures.
(*Operator Dr. H. W. Scarlett.*)

Excision of scar tissue of cheek; undercutting and suturing relieved drag on upper lip and eyelids. Later photograph showed great improvement. (*Operator Dr. H. W. Scarlett.*)

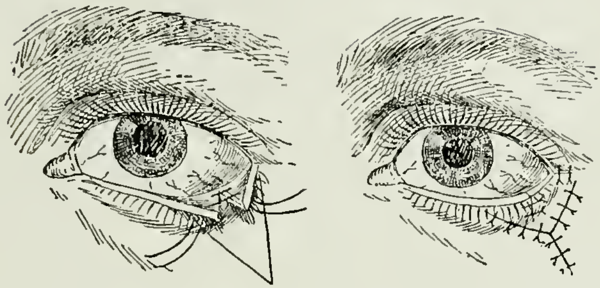


FIG. 232.— V-flap, excision of wedge of tarsus and canthoplasty.

should be closed with care and a compress lightly bound over the eye. The eye need not be examined for two or three days, and the lead plate may be left undisturbed for a week.

The disfigurements due to adhesions of the lids and the bulbar conjunctiva should always be remembered when recent injuries of these structures are first seen. Careful suturing and applications to prevent contact of raw surfaces should be a feature of the treatment when ankyloblepharon or symblepharon is a possibility. possibility.

Either of the lids may be turned out so as to expose the mucous surface. The lower lid is the more frequent seat of the displacement. An overflow of tears is apt to occur if the lower lid be affected. Chronic eversion is followed by thickening of the mucous membrane. The cornea may become ulcerated because

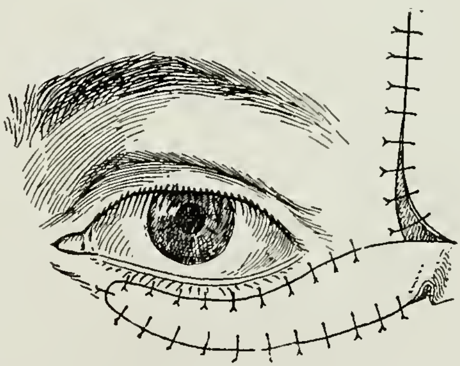


FIG. 233.— Temporal flap to correct ectropion.

its surface is not kept free of irritating particles by means of the normal wiping of its surface by the close-fitting lids.

Ectropion of the lids may be caused by loss of power in the orbicular muscle, as in palsy of the facial nerve and in the weakness of the muscle fibers incident to old age. It results also from traction of scar tissue on the front of the lid, and from pressure from behind, as in exophthalmos, in tumors of the eyeball and in growths of the conjunctiva or lid itself.

The worst deformities of this character are seen after cicatricial contraction has occurred subsequent to sloughing due to burns of the cheek and forehead. In many of these patients portions of the lids have been lost by the gangrenous process and fibrous scar tissue has caused great distortion of the remaining tissue.

Eversion, due to simple inflammatory swelling of the mucous membrane lining the lid, may be cured by scarifying the swollen mucosa and treating the conjunctivitis with astringent solutions. If the conjunctiva is the seat of a chronic thickening which causes eversion, a wedge-shape strip of that mucous membrane may be excised. The strip should be cut across the whole width of the lid from canthus to canthus. In some cases of more marked ectropion this wedge should include the tissues below the conjunctiva just within the lashes. After its incision the lid should be turned inward by two or three mattress sutures. This is similar to the method used by L. Webster Fox. In mild cases of eversion of the lower lid from relaxation a neat operation is that which makes a horizontal cut through the skin just above the level of the rim of the orbit, and goes through the muscle until the mucous membrane lining the internal surface of the lid is reached. This is divided in the same horizontal line at the groove made by its reflection from the lid to the eyeball. The front edge of the mucosa is then drawn down into the wound made in the tissues of the base of the lid and stitched into the cutaneous wound. This dragging of the mucosa of the everted lid downward and a little forward into the skin wound suffices to invert the eyelid and thus restore it to the normal position.

If the lid has attained increased horizontal length, as is common when the eversion has lasted a long time, it is necessary to correct the disproportion in size as well as to turn the lid inward. A wedge taken from the border of the lid will accomplish this

end. This little operation is sometimes sufficient to cause the lid to hug the front of the eyeball without any other step to decrease the eversion. At other times this cuneiform excision may be needed in addition to more elaborate plastic operations to overcome the turning out of the lid. The scar of the wedge-shape wound is least if made near the external canthus. These operations are applicable to eversion of the lower lid rather than to the upper lid.

The strap method of raising the lower lid when everted will occasionally be found available. In this operation the surgeon lifts the outer end of the lid by dissecting a long vertical tongue of skin in the temporal region and attaching its free end, which is

Fig. 234.— Epithelioma near eye excised and flap from temple used to fill space, so as to prevent eversion of eyelid. Temporal wound covered with skin shavings. (*Author's patient.*)

upward, to a higher point on the side of the head than normal. A raw surface is made there by excising a rectangle of skin.

When the ectropion is due to contraction of scar tissue pulling the lid away from the eyeball, the lid must be freed from the displacing cicatrix and restored to its normal relation. To prevent recurrence of the cicatricial dragging, transfer of the tension to the less mobile skin of the cheek, or the interpolation of a pedunculated flap or of a graft of skin is requisite.

An operation often efficacious is the sliding toward the eye of a V-shape flap of skin, cut with its apex sufficiently distant from

FIG. 235.— Restoration of lid by the Fricke flap. (*Harlan.*) Everted upper lid and outline of flap.

FIG. 236.— Operation completed.

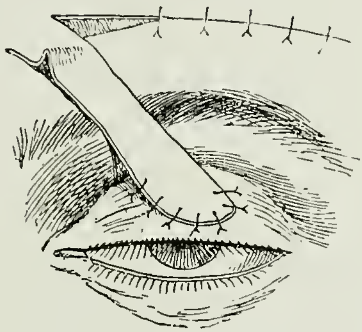


FIG. 237.— Bridge flap from forehead to upper eyelid.

the point of greatest displacement of the lid to allow correction of the deformity. The resulting wound is closed by sutures making a Y-shape scar. This procedure transfers the tension of the scar from a more or less vertical to a horizontal direction. The pull in the latter direction does not displace the lid. The V-flap must be made with its legs beginning close to the lid margin. They must include between them the entire width of the everted part of the eyelid. The whole thickness of the skin must be lifted, and the dissection should be carried so close to the orbital ridge that the everted lid, when replaced in contact with the ball of the eye, may be free from tendency to turn outward again. The apex of the V-flap must be in the line of the scar tension.

Sometimes a combination of the sliding V-flap, excision of a wedge from the margin of the lid and a canthoplasty at the external angle of the eye are needed to correct the ectropic eyelid.

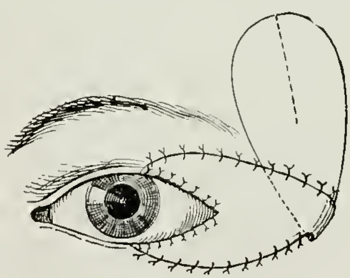


FIG. 238.— Construction of outer canthus with split temporal flap.

When the eversion is great, or when the cicatricial character of the surrounding skin precludes transfer of tension by sliding toward the eye, a V-flap, a frontal or a temporal flap with a pedicle may often be used with advantage. These are to be rotated and inserted in the gaps left after the ectropic lid has been replaced. The pedicle of such a flap is divided when union has been secured, which is usually at about the end of a week or ten days.

The situation from which a flap may be taken to cover the raw surface left, after dissecting loose and replacing the everted eye-

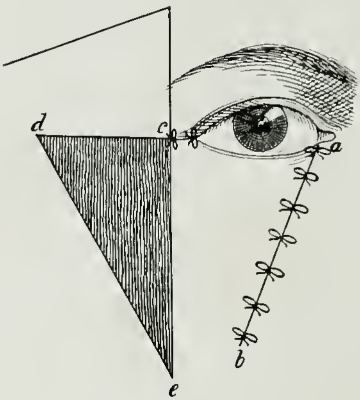


Fig. 239.— Dieffenbach's operation for making lower eyelid.

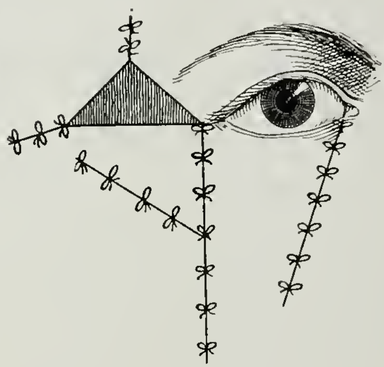


Fig. 240.— Dieffenbach's operation for making lower eyelid completed.

lid, varies with the character of the skin surrounding the eye. The surgeon must determine, before he begins his operation, how he will close the wound left by the transfer of the flap which he expects to utilize to distribute the cicatricial tension. He may for this purpose make, by a series of cuts, many transfers of cellulo-cutaneous tissue, or he may use Thiersch skin grafts, or free flaps of the whole thickness of the skin. The methods described under blepharoplasty will often be required to complete the restoration of the palpebral region in bad cases of ectropion.

RESTORATION OF EYELIDS.

When gangrene or injury has destroyed the greater part or the whole of an eyelid, some form of operation to make a new lid will claim the attention of the surgeon. These more extensive blepharoplastic operations are valuable and important. The protection given the conjunctiva and cornea by the lids is necessary to insure freedom from corneal ulceration and probable perforation. Perforation of the cornea leads to destruction of vision, which may be complete, in the eye so affected.

Fig. 241.—Loss of lower eyelid by shell wound with destruction of right eyeball. *(Courtesy of Dr. H. W. Scarlett.)*

Many ingenious devices have been employed in blepharoplasty. The illustrations here given will sufficiently explain the general principles on which the upper or lower or both lids may be restored. If after the repair has been made there are some

FIG. 242.— Plastic operation on lid with temporo-frontal flap. Enucleation of globe and insertion of artificial eye of glass afterwards. (*Operator, Dr. H. W. Scarlett.*)

remains of the orbicular muscle to enable the patient to close his eyelids, or enough upper lid to permit him to cover the cornea by rolling the eyeball upward by its own muscles, his condition will be satisfactory, even though eyelashes have not been preserved.

Before the flap which is to constitute the new eyelid is put in position the remnants of the injured lid, if there be any, must be

readjusted and vivified. The flap which is transferred or transplanted should have a raw surface for its new bed and be attached by sutures to edges of living skin. The rules for doing aseptic plastic operations must be carefully followed, because the secretions from the eye may infect the wounds and suture tracks, even when the circumstances are otherwise very favorable. I usually suture Krause skin grafts, but am satisfied, when I use Thiersch epidermic flaps, with the pressure of dressings to keep them in position.

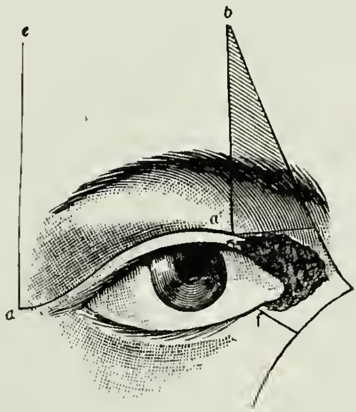


FIG. 243.—Removal of growth from inner canthus.

A method, which has merit in certain cases, is that in which a two pedicle loop, or bridge flap, is cut from just above or below the healthy lid if the skin be voluminous enough. The flap is lifted across the palpebral opening and sewed in the gap left by the loss of the other eyelid. It obtains its blood supply through its attached ends, situated close to the outer and internal canthus respectively. After the new skin has adhered the pedicles are divided and the tissue near each canthus is reconstructed.

In obtaining flaps for extensive plastic repairs of the lids it is frequently necessary to make many transfers to relieve the resultant scar tension which is caused by the displacement of the first flap. The operator should divide tissues freely, provided the proper steps are clear in his mind. A good illustration of

FIG. 244.— Reconstruction of inner canthus by sliding flaps of upper and lower lids to close space left by excision of tumor, after removal of tumor.

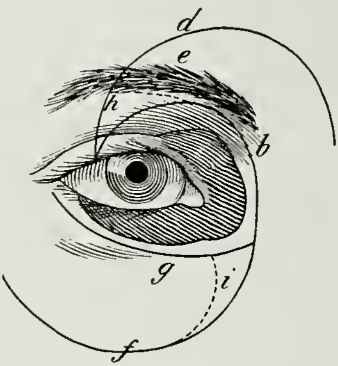


FIG. 245.— Incisions for Hasner's blepharoplasty.

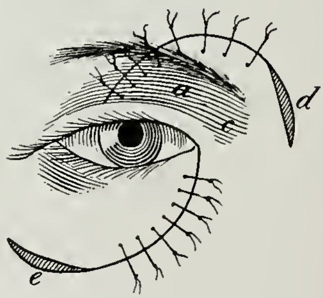


FIG. 246.— Hasner's blepharoplasty completed.

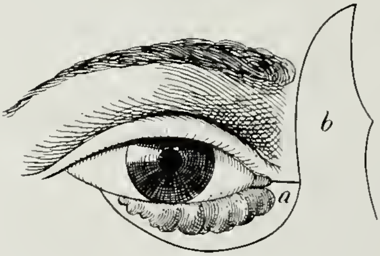


FIG. 247.— Fricke's tongue flap for tumor of lower lid.

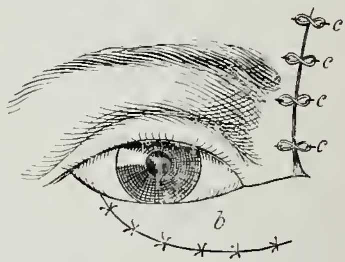


FIG. 248.— Fricke's flaps for tumor of lower lid sutured.

the benefit of such operative breadth is the method reported by Posey and Shumway for creating nearly the whole of both eyelids.

Free, or non-pedunculated, flaps may be used with much satisfaction to fill spaces left by the sliding of flaps to make new lids,

FIG. 249.— Snydacker's blepharoplasty with flap from neck.

to prevent ectropion after removal of tumors, or to complete other operative procedures. The thin hairless skin of the inner part of the thigh or arm or of the region back of the ear may be used. The area from which the flap is to be cut must be sterilized thoroughly and then bathed in sterile physiological salt solution. The region to which it is to be transplanted must be sterilized and similarly bathed. If it is a raw surface, bleeding should be checked; if an ulcerated surface, the granulations

should be free from unhealthy complications and be thoroughly sterilized.

The flap should consist of the whole thickness of the skin and have all the fat on its under surface entirely clipped away with sharp scissors. Its area should be about one-third greater than the space to be filled. When stitched in place it may appear too thick for the purpose. This will usually be corrected by the changes occurring later.

Fig. 250.— Temporal flap to fill space under eye to avert cicatricial ectropion after excision of epithelioma. (*Author's case.*)

A dry sterile gauze dressing should be applied with moderate pressure and left undisturbed for three or four days. When a new dressing is to be applied, the old one should be loosened by saturating it with sterile salt solution. The flap and the adjacent skin should be dried with sterile cotton and a new dry gauze dressing applied and left in place several days. Too frequent dressing is liable to be detrimental by displacing the flap or disturbing the adhering edges. No antiseptics should be used upon it.

Frequently the epithelium and the underlying cells of the flap will break down or be so modified by what appears to be gan-

grene of the whole flap that the operator will be disappointed. In a short time, however, under continued application of sterile dressings, the parts will often show that this process has been only superficial, and that the lower layers of the skin have lived and will close the wound without cicatricial contraction. Occasionally the edges of the flap at places may die, but the bulk of it will be saved.

FIG. 251.— Traumatic loss of upper eyelid. Frontal flap to make new eyelid. Result after a few weeks. (*Author's case.*)

Shavings of skin may be used instead of these flaps of the entire thickness of the skin, when a very superficial covering of a raw or ulcerated surface is desired.

Entropion, or inversion of the eyelid, is a distortion which causes much annoyance to the sufferer without producing much cosmetic deformity. The irritation of the cornea and conjunctiva induced by the constant friction of the lashes growing from the inturned lid may result in important secondary lesions of these structures. These sequels are similar to those resulting from mere irregularity in the direction of the lashes or the manner of their growth, but are more marked when the lid itself is turned inward.

The surgeon who attempts to correct these defects must be familiar with plastic operations about the lids. In addition, the discomforts from inturned lashes or lids may require him to modify or add to his operative plastic work about the eye when he seeks to modify some more disfiguring condition.

The treatment of misplaced eye-lashes, whether trichiasis or distichiasis, and that of entropion, may be considered together. They are often associated. In trichiasis the lashes or some of

Fig. 252.—Ectropion of upper eyelid, after avulsion of entire scalp, treated by frontal and nasal flaps. Skin grafting over cranium. The top of cranium behind was covered with flap from back fastened to skull with carpet tacks. (*Author's case.*)

them grow inward toward the eyeball and consequently rub it. In distichiasis there are two rows of well-developed lashes, one of which turns inward.

In minor instances of ingrowing eyelashes the hair bulbs may be destroyed by thrusting a fine platinum needle attached to the negative pole of a galvanic battery into each follicle and placing the wetted sponge of the positive pole on the cheek. The passage of the current kills the hair and it is easily pulled out and will not be reproduced.

In worse cases the whole length of the edge of the lid may be split with a sharp, thin knife inside the line of lashes, a parallel

incision be made in the skin of the lid beyond the bases of the hairs, and a strip of tissue including all the follicles be dissected away. This, if done thoroughly, scalps the edge of the lid and no lashes can grow thereafter. The edges of the trough left by the incision may be stitched together with fine sutures.

Another method is to split the lid inside the line of the lashes and transplant into the open wound a long elliptical strip of skin taken from behind the ear, or from the skin of the same lid, if it need eversion as well as an improvement in the direction of its lashes. The little strip of skin need not be sutured into its new position if it is pressed into the cut and the eyelids are supported by a sterile compress and bandage for three or four days. A strip of mucous membrane from the inside of the lower lip or a Thiersch graft may be used instead of skin.

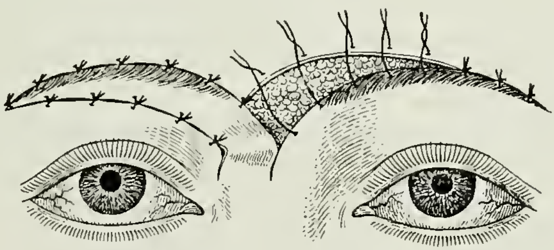


FIG. 253.— A plastic restoration of eyebrow.

Inversion of the lid itself may be corrected by cutting away a narrow horizontal strip of skin on its outside, just beyond the line of the lashes, and making a horizontal incision through the conjunctiva and tarsal cartilage parallel to the lid margin about two millimeters away from the edge of the lid. Stitches of linen or silk are then introduced from the inside of the lid below the internal incision, carried through the lid so as to emerge from the lower part of the cut in the skin, introduced at the upper part of that cut, carried subcutaneously but deeply, and finally brought out through the skin about a centimeter above the upper edge of the skin wound. When these stitches are tied the inverted lid is bent outward so that its edge is no longer curled inward. It is necessary to have the cut on the conjunctival surface go completely through the tarsal cartilage. Otherwise the deformity will be likely to recur from the resiliency of the cartilage.

Harlan has perhaps improved on this operation of Green by splitting the edge of the lid just inside of the eyelash line, and making a horizontal wound on the outside of the lid which removes some of the orbicular muscle as well as the skin.

Sutures are carried from the conjunctival surface out through the intermarginal split, around the eyelash border into the skin wound, through the muscle and out through the skin near the orbital attachment of the eyelid. Such sutures when tied evert strongly the outer portion of the lid with the lashes.

The incurved lid often may be permanently everted by making a horizontal incision through the skin from canthus to canthus, just at the site of the orbital edge of the tarsal cartilage. The lips of the incision are then separated by traction on them, and sutures are so placed that the margin of skin nearer the edge of the lid is fastened to the orbital border of the cartilage, when the threads, which come out through the other margin of the skin wound, are knotted. Four or five sutures are placed in this manner.

In complicated cases there may be required, in addition to this procedure, canthoplasty and the placing of a skin graft in the margin of the lid, as in operating for the cure of trichiasis.

Another operation, which may be available, exposes the tarsal cartilage from the skin surface of the lid and cuts out a horizontal wedge of the cartilage from one canthus to the other. The resected cartilage should then be united by fine sutures so as to convert the inversion into eversion.

The slight spasmodic inversion of the lower eyelid of aged persons may be overcome by painting a little collodion on the cheek just below the lashes. The contraction, occurring when the collodion dries, draws the lid outward. An application every three or four days will usually be sufficient. Care must be taken not to allow any of the collodion to get on the mucous surface, as it will cause pain. After a few applications the spasmodic entropion will sometimes cease to occur.

DEFORMITIES OF THE CORNEA.

When there has occurred severe inflammation and consequent destruction of corneal tissue, as a result of injury or ulceration, the scar which remains after the healing has an opaque white

structure and is called a leucoma. This is so different from the normal transparent corneal tissue that it greatly disfigures the patient. If there has been perforation of the cornea and prolapse of the iris, the iris becomes adherent to the cicatricial tissue which repairs the opening in the cornea, and there remains an adherent leucoma. After the destruction of a large area of the cornea from any cause, the iris, the remains of the cornea and the inflammatory exudate, which are welded into a scar, are often too weak to resist the pressure of the humors within the eyeball. The intra-ocular tension, therefore, gradually stretches the cicatricial wall which has taken the place of the transparent and tough cornea. The front of the blind or partially blind eyeball consequently bulges and protrudes between the eyelids. It may be impossible for the patient to cover the protruding corneal protrusion by even the greatest effort to close his lids. This condition is called staphyloma of the cornea.

Similar protrusion may follow injury to the sclera. Sometimes a corneal staphyloma is accompanied by similar stretching of the sclerotic coat adjacent to the cornea.

These bulging masses between the lids are very unsightly and should be removed when the vision of the eye has been entirely lost. In the major degrees of staphyloma the original affection has long before destroyed the utility of the eye as an organ of sight. After still more extensive destruction of the eye from traumatic or other forms of inflammation, the whole globe becomes atrophied, and remains in the socket as a movable but shrunken and sightless globe. If such a condition of the eye occurs in early life, the bones surrounding the eye fail to develop as fully as do those on the other side of the face. Consequently the quarter of the face in which the blind and atrophied organ is situated is considerably smaller than the corresponding region of the other side. This partial atrophy is a disfigurement and should be averted so far as possible in growing persons by replacing the atrophied and useless organ by an artificial substitute, which by its bulk may encourage the natural growth of the skeletal surroundings of the eyeball.

The white scars on the cornea, termed leucoma, may be made much less disfiguring by tattooing them black with India ink. The cornea is made anaesthetic with a cocaine solution of about

4 per cent. strength, and a smooth paste of India ink, prepared by rubbing the pigment in sterile water, is picked into the white scar with a number of needles attached to a handle. The needle punctures should be made obliquely into the corneal scar. The eyeball is to be steadied by the finger and the paint may be rubbed upon the cornea with a finger tip. It is unwise to grasp the conjunctiva of the eyeball with forceps to steady it, because particles of the pigment may become imbedded by chance in the small wounds thus made. Several repetitions of the tattooing at not less than two weeks' intervals are usually necessary to gain sufficient color. The work should be done aseptically and the eye be permitted to recover from the irritation of one operation before another is done. The eye must be thoroughly cured of the original inflammation which caused the leucoma, and free from irritation, before the first tattooing is undertaken. The operator must be versed in the diagnosis of eye diseases and the treatment of complicating possibilities before attempting even this simple procedure upon the eye. After each tattooing the eye should be atropinized to avert any possible adhesions due to an unexpected iritis or iridocyclitis.

It is best in leucoma covering the center of the cornea to tattoo a black spot in the middle to represent a pupil, and leave a narrow circle of white around this central spot. Beyond this white circle the rest of the leucoma may be colored. This plan gives the eye a fairly natural appearance.

Other colors have been tattooed into scars of this kind in an endeavor to imitate the color of the iris. The change of the glistening white surface of the leucoma to a more or less black tint usually is sufficient to lessen the noticeable disfigurement. The operation should not be done on thin scars.

Transplantation of disks of transparent cornea from human eyes or from the eyes of lower animals has been done. The graft has become necrotic or finally opaque in nearly all, if not all, cases reported. Future success seems, however, a possibility. A corneal trephine is used to cut out the leucoma and to punch the graft from the eye of the donor. After the disk-shape graft has been put in place, it may be held in position by suturing a fold or flap of conjunctiva over it and the cornea.

A small partial corneal staphyloma may be removed by ellip-

tical excision; the edges of the wound may be brought together by fine sutures or by the pressure of a firm compress under the dressing. A convenient way to accomplish the excision is to transfix the bulging part with a cataract needle to steady it. The protuberance is then removed by a curved incision, with knife or scissors, on each side. The crystalline lens should be extracted from the eye.

A total staphyloma should be amputated. This is done by thrusting from above downward three or four curved threaded needles through the ball, behind the ciliary region. The bulging mass is cut away and the lens removed; then the edges of the scleral stump are brought into contact by pulling the needles through the tissues and tying the sutures.

Instead of using the transfixing needles a single needle may be thrust through the conjunctiva behind the ciliary region in a manner which will carry a purse string around the mass that is to be removed. This requires that the needle make four punctures. After the staphyloma has been cut away, and the lens extracted, tension on the ends of the single suture will close the gaping wound and keep the vitreous humor from escaping from the cup-like scleral stump. Care must be observed not to unconsciously cut the buried purse string with the knife or scissors used to excise the projecting scar tissue.

Some operators advocate enucleation of the eyeball or its evisceration with the insertion of an artificial vitreous body instead of amputation. Their reason is the fear of ophthalmitis in the eye operated upon or sympathetic inflammation of the normal eye.

These complications are rare in well-performed aseptic operations, in which the lens is evacuated and the staphyloma removed by incisions behind the ciliary region. The movable stump thus left after removal of a total corneal staphyloma forms a good support for an artificial glass shell eye; and the vitreous body enclosed in the scleral cup is better than a glass, metal or paraffin substitute for the vitreous body.

There are undoubtedly cases, however, in which evisceration of the globe, with or without the use of an artificial vitreous body, or enucleation, may be wiser than amputation of the staphylomatous mass.

Removal of the eyeball itself in young subjects is much more likely to cause a want of proper growth of the bones of that side of the face than an operation which leaves the posterior part of the staphylomatous eye in the orbit.

Atrophy of the eyeball occurring after destructive inflammation may permit the wearing of an artificial eye. If the glass shell causes pain or if the blind organ is painful from any cause, its enucleation is to be recommended. An artificial eye may be then inserted and will lessen the disfigurement.

In cases of unusual difference in the size of the eyeballs, because one eye is congenitally too small, some cosmetic improvement may be made by lessening the palpebral aperture of the larger organ by tarsorrhaphy and increasing that of the other by a canthoplasty.

When exophthalmos remains after partial or nearly complete recovery from Graves's disease the staring eyes can be greatly improved cosmetically by suturing the edges of the outer canthus and thus diminishing the excessive size of the opening between the lids.

In enophthalmos, due to fracture of the orbital bones with sinking of the eyeball, the other eye may be made to correspond in size by suturing the outer canthus. The noticeable lack of cosmetic symmetry may be thus remedied easily and without risk.

It is perhaps possible that some improvement might be made in congenital absence of the globe of the eye by plastic and prosthetic surgery.

A blind eyeball, which is unsightly from staphyloma or which does not permit a glass eye to be worn over it, may be removed entirely by the operation called enucleation. As has been previously stated, staphylomatous corneas may be made satisfactory as to comeliness by removing the anterior section of the ball and adjusting a glass shell to the stump. Instead of entirely removing the eyeball, by cutting its muscles, the optic nerve and the connective tissue about it, the operation of evisceration may be performed.

This procedure removes the anterior part of the eye, as in amputation of a staphylomatous cornea, but in addition scoops or wipes out of the containing sclera the iris, ciliary body, choroid,

retina and vessels, leaving a perfectly clean and aseptic sclerotic cup. As this posterior scleral section has the extrinsic muscles of the globe attached to it and partially fills the cavity of the orbit, the artificial eye worn over it fills out the space under the eyelids quite well and has a great deal of mobility. The cosmetic gain is therefore great compared with that obtained when using a glass shell after an enucleation. Then the stump is too small to fill up the cavity formerly occupied by the eyeball and the upper eyelid drops back into the orbit. This causes an unnatural hollow under the eyebrow.

A still better stump for the adaptation of an artificial eye shell is secured by introducing into the eviscerated sclerotic a ball of gold, glass or paraffin, which being aseptic remains enclosed within the sclerotic of the eye for years without causing disturbance. The stump thus distended makes, when covered with a glass shell, an almost perfect companion for the normal eye of the other side. The artificial vitreous body within the scleral cup makes a mass nearly the size of the normal eyeball. The glass shell over it is made to represent the normal pupil, iris, and conjunctiva in size, color and shape, and the muscles which were left attached to the sclerotic give the artificial eye motion which coordinates with those of its companion eye.

Evisceration with introduction of the artificial vitreous body called Mules's operation, is a marked improvement cosmetically over enucleation.

A glass or gold globe to constitute an artificial eyeball is sometimes introduced with success into the capsule of Tenon after enucleation has been done. This is an improvement over enucleation of the ball without the use of the gold or glass substitute, but does not give so good a cosmetic result as evisceration with the artificial vitreous body.

In these operations, all of which require general anaesthesia, the eyelids are kept widely apart with an eye speculum. Enucleation is done by making with scissors a circular division of the conjunctiva around the cornea. The rectus muscles are then successively raised with a strabismus hook and cut off close to the ball, leaving, however, at one place, a sufficient stump attached to the globe to give opportunity for the surgeon to hold and manipulate the eyeball with a pair of toothed forceps. The

optic nerve is cut off at the apex of the orbit by slipping a pair of round end scissors curved on the flat into the orbit between the ball and the conjunctiva. The scissors should be kept close to the eyeball as they are pushed backward, and not opened until they reach the nerve. It is best to introduce them at the external side of the globe. After the nerve has been cut, the connective tissue and oblique muscles still attached to the eyeball are divided. Then the liberated globe is lifted out through the circular wound in the conjunctiva by means of the forceps, which have been holding on to the ocular stump of the first rectus muscle divided. The four rectus tendons are now drawn forward and sewed to the edge of the conjunctival wound. Then the capsule of Tenon and the conjunctiva are closed by sutures, which unite the edges of the opening in these tissues so as to leave a horizontal wound. A compress and bandage are applied.

In order to fill out the orbit and prevent collapse of the upper eyelid, a hollow sphere of gold, or glass, may be implanted in the cavity left with Tenon's capsule by the removal of the eyeball. The operation must be done aseptically and the artificial eyeball must be aseptic. After the eyeball has been enucleated as already described, the space within the capsule is packed for a few minutes with a ball of sterile gauze until bleeding ceases. Then the hollow sphere is dropped into the cavity vacated by the enucleated organ and the capsule and conjunctiva sutured over it. The balls so introduced vary in size from ten to fourteen millimeters in diameter.

If the enucleation has been done some time previously, the orbital tissues are opened by a sufficient incision at the upper lateral part of the tissues, a pocket is made by dissection with scissors and the sphere of gold or glass is inserted. Sutures are used to close the wound.

The operation of evisceration is begun by dissecting the conjunctiva from the anterior part of the globe of the eye through a circumcorneal incision. After exposing the globe as far back as its equator, the cornea and a little of the adjacent sclera is cut away with knife and scissors. Then all the contents of the sclerotic coat are scooped out with a small spoon. If these are not completely removed with the spoon, the cavity must be cleared of fragments by mopping with cotton or gauze tufts held

in forceps. The scleral cup may require firm packing with gauze for a few moments to stop bleeding. The circular opening in the sclera should be converted into a more elliptical form by removing small triangular pieces above and below, to render accurate closure possible. Sutures are then used through the conjunctiva and sclera to draw the wound edges together. A compress of gauze completes the dressing.

Into the eviscerated sclera a hollow sphere of glass or gold or a solid sphere of paraffin may be implanted. Before the artificial vitreous body has been inserted all particles of choroid and other contents must be carefully and aseptically removed. The interior of the sclera must be white and glistening. The sphere, if not too tight a fit, is then dropped into the schleral cup and the scleral wound closed vertically with a few interrupted linen or silk sutures. The conjunctiva is sutured so that the wound is horizontal. A compress and a bandage are applied and the dressing may usually remain unchanged for two days. This operation was devised by Mules.

Dr. L. Webster Fox prefers to cut the rectus muscles free from the globe of the eye after the ball has been inserted and the sclerotic coat stitched. Then, when he closes the conjunctiva, he is careful to include in his sutures the capsule of Tenon. This replaces the ends of the rectus muscle close to the eyeball again and they become attached to it. This method, he believes, prevents muscular strain on the scleral sutures during the early healing of the opening in that coat. Therefore there is less danger of the artificial vitreous body being expelled through an imperfectly healed scleral wound. By drawing Tenon's capsule forward by means of the conjunctival sutures the reattachment of the muscles to the eyeball is attained. Consequently the movements of the stump and the adjusted glass prosthesis are secured.

He also places over the conjunctival surface a glass or metal "conformer," which, lying under the closed eyelids, steadies the scleral stump like a splint. Sterile petrolatum is smeared over the closed lids. Moderate pressure with the bandage or compress is to be maintained for about forty-eight hours. Dr. Fox removes the "conformer" and the conjunctival sutures on the third or fourth day.

The extirpation of the contents of the orbital cavity in addition to removal of the eye is sometimes important, because of the existence of malignant disease of the eyeball and its surroundings. This operation is called exenteration of the orbit. It is performed by opening with a knife the tissues within the lids near the border of the orbit. The lids must be held open with a speculum for the operation and the external canthus may be split. The periosteum just within the orbital edge is then split with the knife. This permits the operator to detach the periosteum from the inner surface of the wall of the orbital cavity all the way back to its apex. Care must be taken not to perforate the thin roof, lest intracranial complications occur. The entire contents of the orbit are then removed by dividing the posterior attachments with scissors. It makes the operation somewhat easier to enucleate the globe of the eye before detaching the periosteum and extracting all the orbital contents. This may not be convenient if the eyeball is greatly involved or partly destroyed by the malignant growth. After exenteration the cavity may be lined with skin grafts or Thiersch's skin shavings. Krönlein's temporary resection of the outer wall of the orbit, to get access to tumors in the orbit not manageable by less extensive operations, will be described when I discuss deformities from orbital growths.

After total or partial removal of the eyeball or its substitution by globes placed in the capsule of Tenon or in a scleral cup, it is usual to adjust to the stump a glass representation of the cornea, iris, sclera and conjunctiva. The glass shell usually employed for this purpose may be applied over an atrophied eyeball, but such practice, as a rule, is not a wise one. It is better to get rid of the atrophied ball totally or in part and then resort to the glass prosthesis.

The use of an artificial eye is valuable not only for improving the appearance of the patient, but also for preventing the entropion and the falling in of the eyelids, which are apt to occur when the support normally exerted by the eyeball is lost. The rubbing of the lashes against the conjunctiva is often painful and may give rise to a mucopurulent discharge, which will excoriate the skin of the cheek. These pathological and cosmetic disadvantages may be overcome to a great extent by wearing a glass

eye over the stump left after enucleation or evisceration. An additional benefit is that atrophy of the face in the ocular region, common in growing children, who have lost an eye, is to a considerable extent prevented.

The glass or enameled shell represents the front of the eyeball and is made to match the color and size of the iris, cornea, sclerotic and conjunctiva of the other eye. It is slipped under the upper lid and rests with its lower edge in the conjunctival groove within the lower lid. The muscles formerly inserted into the sclera of the globe of the eye, which have been preserved and attached to the stump, give it and the overlying shell a considerable degree of concomitant movement with the other eye. If the lateral movements of the organ are fairly good, the eyelids able to close over the artificial eye, and the color and size of the substitute the same as those of the normal eye, the casual observer may not detect that one eye is a sham. The sinking in of the fold of skin above the upper lid, due to the loss of ocular support, may be prevented, the normal position of the upper and lower eyelashes be obtained, and winking and the coordinate movements of both eyes be satisfactory, if a partially shrunken ball remains or the bulk of the stump has been increased by a sphere of glass or other material. Unless the surgeon has been successful in meeting these requirements, the patient may be more comfortable and less disfigured by allowing the lids to rest closed upon the vacant orbit than by wearing a badly fitted and badly matched glass eye. The shell is not well tolerated as a rule by a stump in which there remains any normal cornea.

The glass eye must be smooth on the surface and have no sharp edges. Its shape must correspond to a certain extent with the cicatricial requirements of the conjunctival pouch in which it is to be worn. An eye a little too small may be worn with much comfort, but one too large is a source of discomfort and disfigurement. A small glass eye may have its cosmetic effect improved by wearing in front of it a convex spectacle lens to magnify it and make it match its fellow in size. The normal eye should have in the spectacle frame a plain glass or that which will correct any existing refractive error. A furrow above the upper eyelid of an eye, from which the globe has been enucleated, may be concealed by wearing a spectacle or eyeglass frame made wider than is usual.

When the glass shell loses its smooth surface or gets sharp on the edges, it must be rejected or have its surface and edges repolished. Otherwise it will cause conjunctivities and perhaps ulceration and contraction of the conjunctiva. These sequels may render the use of a substitute eye impossible. A good shell will last from one to three years. The time varies with the character of the secretions of the eye and the quality and material of the artificial eye. The patient should take out the eye when going to bed at night and replace it in the morning. It should be thoroughly washed with a mild antiseptic, or an aseptic solution, and dried. When it is to be inserted in the morning it should be moistened and replaced with clean fingers. The cavity under the eyelids should be kept aseptic by washing morning and evening with a solution of boric acid of about five grains to the fluid ounce of water.

After removal of the globe by one of the methods already described, an artificial eye may be inserted as soon as inflammation has subsided. This may be after the lapse of say three weeks in the usual case. At first it may be worn for a few hours repolished. Otherwise it will cause conjunctivitis and perhaps postponed until subsidence of the post-operative irritation. It is not well to wait a very long time, because conjunctival and palpebral contraction may occur.

To introduce a glass shell the patient should be looking upward. The upper lid is then drawn forward by the finger of the surgeon, or of the patient himself, making traction on the skin below the eyebrow. Then that edge of the shell which has most sclerotic represented is slipped under the upper lid. The lower lid is next drawn down a little by traction on the skin below it, so that the lower edge of the shell may slip over it and drop into the lower conjunctival groove. The patient then is allowed to wink and the shell assumes the proper position. It may require the insertion of several glass eyes before one is found which is comfortable and a good match as to size, color and movement. To remove the artificial eye the patient should look upward and insert the head of a large pin or any similar blunt instrument beneath its lower border so as to tilt it out over the edge of the lower lid. This is soon learned and may be done quickly by simply everting the lower lid with the finger and moving the

stump on which the shell rests. Until the patient becomes dexterous in introducing and removing the shell he should lean over a bed, lest the glass eye be dropped on the floor and broken.

Instead of the shell, a thicker eye of glass, with or without a central cavity, and with less sharp edges, has been found satisfactory by some ophthalmic operators. Its under surface does not leave a deep hollow for the collection of secretions as does the shell of glass.

Other forms have been manufactured for special cases, as in eyes with very deep or irregularly cicatrized sockets. The latter may have a long tongue of glass on one edge to hold the shell in place.

When a socket has become contracted or cicatricial, it may be too small to admit an artificial eye. Attempts to enlarge the socket may be made by splitting the tissues freely horizontally and perhaps vertically and inserting a free flap of mucous membrane taken from the inside of the lower lip. This may be stitched in place or simply laid in contact with the raw surface. Thick Thiersch skin-grafts, or skin-grafts taken from behind the ear or elsewhere, can be similarly applied. A ball of gauze or glass or some form of plate or conformer may be inserted under the lids to hold the graft in position before the lids are closed and dressed with an aseptic compress. It may perhaps be better to split the outer canthus and turn into the orbital cavity a pediculated flap from the temple. When this flap has become attached to the bottom of the socket the pedicle may be divided and the canthus closed.

OCULAR DEFORMITIES FROM ABSCESS OR IMPACTED PROJECTILES.

Impacted bodies, as well as growths in the orbit, produce facial disfigurement by displacing the eyeball, preventing proper closure of the lids, and by causing bulging of the bones, which constitute the walls of the orbit.

Tumors or large pus collections or pieces of shell or shrapnel may cause exophthalmos, or protrusion of the entire ball, or deviations, usually to the side away from the object causing pressure. They often cause double vision by displacement of one globe.

Mucous retention and abscesses associated with disease of the

frontal or ethmoid sinuses also encroach upon the orbit and must be remembered. Fractures and gunshot wounds of the intracranial blood vessels may cause a pulsating exophthalmos with pulsation and aneurismal thrill in the protrusion. Such cases must be studied with care and treated by an endeavor to shut off the blood current in the wounded artery or vein.

Some orbital foreign bodies are removable without sacrificing the eye itself, while others are reached only after a temporary resection of a part of the orbital wall.

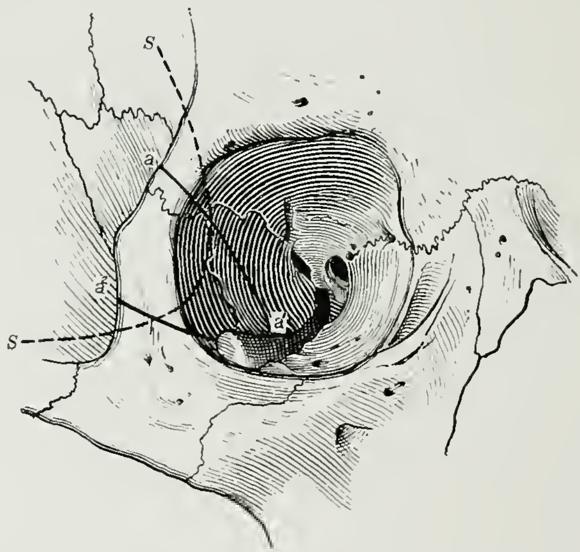


Fig. 254.— Kroenlein's operation of temporary resection of outer wall of orbit to remove orbital growths. (*Knapp.*)

If access to the seat of the bullet or other missile is desired for extraction without damaging the eyeball, a cut is made at the bony margin of the orbit and the orbital fat and the eyeball with its attached muscles are displaced so that the imbedded projectile may be enucleated. The object is then removed with forceps, the wound disinfected, and the globe of the eye permitted to fall into its place. Drainage may or may not be necessary. The

external side of the orbit perhaps gives better access to the orbital cavity than other regions, but the site of the bullet must be a guide to the route. If necessary, the external canthus of the eye may be split, to afford room for operating. At times it may be necessary to divide the tendon of the external rectus muscle temporarily. In such cases the ends of the tendon should be secured by sutures, which may be used to unite the tendon when the operation wound is being closed. Mucoceles, communicating with the accessory sinuses of the nose, and abscess around septic missiles situated within palpebral or orbital tissues, are to be incised and drained.

When extraction or evacuation cannot be successful, unless abundant room is given for the operator's work, temporary resection of the external orbital wall, as devised by Kröenlein, or some similar method, is to be adopted.

In this operation a curved incision, through the skin and fascia down to the bone, is made over the outer part of the orbital border with its convexity toward the eye. The ends of this cut run up on the temple and outward along the upper edge of the zygoma. Next the periosteum lining the outer orbital wall is incised and detached along the exposed edge. It is then loosened from the wall and pushed toward the eye, until the front end of the spheno-maxillary fissure in the outer and lower part of the orbital wall is uncovered. This is marked by putting the end of a probe into it. A small sharp osteotome is then used to cut out a wedge-shape piece of the bony outer wall of the orbit. The lines along which this bony segment is cut run from the anterior end of the fissure mentioned. One line runs upward and outward, passing through the margin of the orbit at a point near the junction of the external angular process of the frontal bone and the malar bone. The other runs outward and a little upward, dividing the ascending process of the malar bone near its base. If a chisel is used it should be driven from the exterior of the orbital margin in the lines mentioned to the end of the fissure, in which a probe has been already thrust for a marker. A small nasal wire saw may sometimes be convenient in these operations. The wedge of bone thus detached should measure about one and a half inches vertically and run about two inches in length into the orbit. Splitting the periosteum, which has been detached

before the osteoplastic resection is made, and then turning the bony wedge and the soft parts attached to it outward and backward, enable the operator to expose the deep parts of the orbit. After the cavity has been cleared of fragments of bone, particles of clothing and the projectile itself, drainage should usually be effected and continued for several days.

CHAPTER XXIV.

SHELL SHOCK, TRAUMATIC NEUROSES AND GUNSHOT INJURIES TO NERVES OF THE FACE.

Soldiers who have received injuries under circumstances of great fright or horror may, even if the organic injury be slight, suffer profound nervous and mental depression. Those of a neurasthenic or hysterical disposition may develop similar symptoms from insignificant injuries, unaccompanied by any special horror or anxiety. Many cases of shell shock belong to the hysterical and neurasthenic groups. These patients are difficult to differentiate from malingering. The accompaniments of war wounds of the face are such as to induce despair and deep psychic impressions. Blindness, deafness and aphonia will, therefore, be present in a fair proportion of cases.

The symptoms vary, but the fact of the injury is usually so impressed upon the mind of the patient as to determine their character, at least to a certain extent. Among the general symptoms are irritable and frequent pulse, headache, sleeplessness, indigestion, mental foreboding, loss of memory, disturbances of vision and loss of strength and weight. The hysterical manifestations seen in such cases are those seen in hysteria unconnected with a traumatic cause, and may include epileptiform attacks, local loss of muscular power, anaesthesia, hyperaesthesia and vaso-motor changes. It is important not to confuse shell shock with surgical shock and fat embolism.

The traumatic neuroses are often very difficult of diagnosis, because their resemblance to gross organic lesions is great. It is difficult, for example, to be certain that no damage was done to the viscera when persistent vomiting and grave deterioration of health have followed a blow on the epigastrium. Careful observation will usually convince the surgeon that the blindness and other symptoms are psychic and not due to structural damage.

The treatment consists in encouraging the patient, allaying his forebodings, building up the health with tonics, and gradually directing his mind away from his symptoms. The management

of this class of cases demands the highest professional skill; and is often unsuccessful until the patient is separated from sympathizing and solicitous friends. The present European war has developed many cases of traumatic neurosis, for which special lines of treatment have been developed by neurologists.

Wounds from projectiles frequently divide important nerve trunks of the face. At other times these structures are partially divided, contused, or subjected to pressure by scar contraction. Injury to motor nerves, such as the hypoglossal and facial, may cause temporary, partial or complete paralysis of muscular power. Incomplete destruction will usually be followed in time by regeneration and return of motion in the tongue, in the muscles of expression or those of mastication. If section of the nerve trunk has been complete in the portion outside of the cranium, total palsy will be present; the nerve should then be exposed and nerve suture performed. Deep bullet wounds of the neck may divide the hypoglossal near its cranial exit, close to the vertical column. The facial may be damaged within the aqueduct of Fallopius in the temporal bone or at or before its exit from the stylomastoid foramen. Extraction of the missile and nerve suture will in both instances present rather serious problems. Location of the projectile by means of x-ray plates, and its extraction through a proper incision, may be followed in some instances by successful suture. Nerves recover motion slowly after suture. The sensory nerve fibers recover function more rapidly than do those of motor nerves.

Penetrating wounds of the orbit involving the motor nerves of the eyeball induce various degrees and forms of strabismus.

The sensory nerve when inflamed or compressed by scar tissue may be the seat of excruciating pain. This may make it necessary for the surgeon to excise the compressing fibrous tissue or to cut out a piece of the nerve. Neurectomy may be only possible through a formal operation to reach the nerve behind the point of constriction or injury. In the case of the branches of the fifth or trigeminal nerve, the operations to reach the nerve, in order to do neurorrhaphy or neurectomy, are like those employed for the peripheral operations on its three branches to relieve pain in tic douloureux or prosopalgia. The lingual nerve is reached within the mouth along side of the tongue. Palsy of

the facial nerve distribution is sometimes due to intracranial damage from bullet wound of the brain centers or of the portion of the nerve within the cranium. The spinal accessory nerve may be divided in the neck and its central portion be sewed to the distal part of the paralyzed facial nerve. This gives motor function to the orbicular muscle of the eyelids, to that of the mouth and the other muscles of expression, because it conducts impulses from the brain to the branches of the facial nerve which had lost their brain connection. Plastic repair is described on p. 334.

Section of the hypoglossal nerve by gunshot wound is well illustrated by a patient operated upon by me some years ago. The man had received a bullet wound of the left cheek over the ramus of the lower jaw about three-quarters of an inch below and three-quarters in front of the lower edge of the lobe of the ear. The left side of the face was covered with sweat; the right side was dry. The left pupil was slightly dilated but seemed to react to light. The left facial nerve was paretic but not completely paralyzed. Dr. William G. Spiller believed that the upper branch of that nerve had probably escaped injury because the man could nearly close the eyelids of the left eye. The left side of the tongue was completely paralyzed so that the organ by use of the right and uninjured right hypoglossal nerve deviated strongly to the left when it protruded; while in the mouth it deviated to the right somewhat. The sympthetic nerve Dr. Spiller believed had been injured, as shown by the eye, and thought the pneumogastric and nasopharyngeal were probably uninjured. By the x-ray examination the bullet was located in front of the spinal column close to the base of the skull. An incision around the angle of the mandible permitting the parotid gland to be pushed forward enabled me to insert my finger by burrowing until it found a movable object behind the pharynx close against the second and first cervical vertebra. The movable object was proved by the use of the Nélathon porcelain probe to be a bullet. The missile was removed from the depression in front of the vertebra where there were some loose fragments of bone felt by the finger. A drainage tube was inserted. The wound became slightly septic but it healed in a rather short time. Pleural pneumonia not connected with the wound developed and the man left the hospital in about a month with the bullet

wound healed, but died later in another hospital with what was believed to be tuberculous bronchopneumonia.

Pathological examination showed at autopsy no connection between the wound which cut the facial nerve close to the exit from the anterior condylar foramen, and proved that the body of the first as well as that of the second cervical vertebra had been entered by the bullet to the left side of the median line. The case was reported in the Annals of Surgery, 1908, Vol. II, page 155.

CHAPTER XXV.

NEURECTOMY OF NERVES OF THE FACE.

In exposing nerves there is no objection to raising a flap of skin and superficial fascia so as to get room to see the anatomical relations. It was formerly the custom in ligating arteries and exposing nerves to make a linear incision; but it will be found in both cases that a sigmoid cut or a semielliptical flap will make identification of the landmarks much more easy.

Facial.— An angular incision about two and a half inches long is made immediately behind the auricle with the apex of the angle pointing backward over the tip of the mastoid process. The nerve will be found in the bottom of the narrow space between the sterno-mastoid muscle behind and the parotid gland in front. It lies at the depth of about one inch and upon the fascia covering the muscles on the front of the vertebral column. The nerve is rather small, but will be found about a quarter or half an inch in front of the middle of the anterior edge of the mastoid process.

Spinal Accessory.— A three-inch incision along the anterior edge of the sterno-mastoid muscle, and beginning at the point of the mastoid process, will enable the surgeon to reach this nerve. The cervical fascia should be opened, the tissues of the neck relaxed, and the sterno-mastoid muscle drawn outward and backward. The nerve will then be found crossing the transverse process of the atlas.

The supraorbital nerve is reached by an incision along the supraorbital arch, after which the nerve should be cut off as far back in the orbit as possible. If the nerve comes through a distinct foramen, this foramen may be converted into a groove by cutting out the edge of the bone with a chisel, and then a hook can be inserted above the globe of the eye so as to enable the surgeon to drag the nerve forward. The best exposure of the infraorbital nerve is obtained by an osteoplastic resection of the malar bone, which is sawed through near the infraorbital foramen and near the zygoma and frontal bone and turned outwards. This operation gives opportunity to remove the nerve back to the round opening, whence it comes from the cranium.

The inferior dental nerve is easily reached by trephining the ramus of the mandible just below the sigmoid notch, thus exposing the nerve before it enters the inferior dental canal. The trephine opening may be expeditiously made with a small fissure burr, or a trephine, driven by a surgical engine, as suggested by me for cranial trephining in 1882, or an ordinary hand trephine may be used. The second step is to uncover the mental foramen on the same side of the jaw, after which the roof of the entire length of the mandibular canal is to be removed with a chisel or

Fig. 255.—Making osteoplastic cranial flap on cadaver with Masland saw (Model 1918) and Roberts's trephine made in 1882 for trephining with Bonwill dental engine. Figure also shows bone graft wired into mandible after employing Masland saw. (*Cadaver operation.*)

Fig. 256.—Osteoplastic flap so made everted to expose anterior branch of middle meningeal artery. A similar craniectomy may be done to expose roots and ganglion of trifacial nerve.

an electric driven circular saw. The nerve is then lifted out of the canal and three or four inches are excised.

The Gasserian ganglion, or better its sensory root, may be reached for excision in inveterate spasmodic neuralgia through a trapdoor opening in the temporal region of the cranium. By this strategic osteoplastic approach the base of the brain becomes accessible. The cerebrum with the dura mater is lifted from the floor of the middle fossa, and after careful hemostasis a piece of the sensory root is excised.

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